FENDER   MUSICAL INSTRUMENTS

CHROMA   COMPUTER INTERFACE

Model 1611

REV 6

SEQUENCER MANUAL

Tony Williams

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APPENDICES

* These appendices are in the Computer Interface Document, available seperately.

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INTRODUCTION : CHROMA COMPUTER INTERFACE KIT

General Description:

The Chroma Computer Interface kit contains everything you need to connect a Chroma, Chroma Expander, or Chroma Polaris to an Apple II Plus or Apple IIe personal computer. When installed, the synthesizer can send and receive live performance and programming information. A multitrack sequencer software package is included to get you started. Other utility programs may become available, or you can write your own software utilities. With the Chroma's sophisticated command oriented communications language, it is the most versatile computer music terminal. Now you can create your own computer applications.

Chroma Computer Interface:

Anything that you play, select, or move on the Chroma and its accessories can be sent to a computer or other device over the Chroma Interface (CI). The external computer can then store the data and send it back to the Chroma in the form of a digital recording or sequence. As you can see, the Chroma and its interface are useful for studio as well as live performance and educational applications.

Chroma Interface Command Set:

The Chroma line of synthesizers are structured around the interface - not just modified to accomodate it. They have available eight (8) logical 'instruments', each of which may be programmed and played individually by an external computer. The interface command set is extremely versatile, including commands such as ATTACK, RELEASE, PEDAL 1, PEDAL 2, PITCH BEND, MODULATION LEVER, LATCH, SUSTAIN, VOLUME, PRESSURE, SET VOICE PARAMETER and others for each 'instrument'. Also included are commands for saving and loading voices, saving and loading packets of data from the cassette interface, peeking and poking into the Chroma's internal memory, and reading or changing the values of any program in CMOS memory. Currently, there are a total of 166 such commands and room for expansion to 255.

Sequencer Hardware and Software:

Fender now has available hardware and software to allow any
two synthesizers from the Chroma product line and an Apple II
Plus or IIe computer to talk to each other. Included with the
package are a set of application programs (in Applesoft and
Assembly Language) that perform sequencing, editing and program
data storage functions. The Sequencer can record up to 16
independent tracks and can simultaneously control any two Chroma
synthesizers. The Sequencer is fully polyphonic and records key
velocity and pressure as well as ALL performance controls and
voice changes.

Interface P. C. Card:

The printed   circuit   (PC) card hardware is required to
establish communication between the Chroma and Apple. Each
hardware port consists of two unidirectional 8-bit parallel
ports and four control lines.
The   PC card also incorporates a 1000 Hz clock for
sequence timing and an Analog-to-Digital converter for pedal
input of speed changes, etc. There are other inputs for a
footswitch, sync pulse and an external clock (for connecting to
drum synthesizers and other sequencers, etc.). There is also a
filtered pulse output for a audio click track. And finally,
there are extra read and write pulses available if you want to
modify the included hardware for your own software.

Sequencer Software:

The Interface I/O Driver software performs all the functions
necessary to get data to and from the two ports. This driver,
along with the Sequencer application software, is included on the
Sequencer Program diskette. This software receives data from the
Chroma and formats it for storage on the Sequence Data diskette
in Drive 2 (or on the Sequencer Program diskette, if you have
only one drive). To record a track, all you really need to do is
press 'R,' select a voice on the Chroma, press a footswitch and
start playing. The Sequencer will remember all notes with
velocities and pressures, all lever and pedal movements, all
footswitch depressions, all voice changes, and even movements of
the parameter control slider. When recording subsequent tracks,
you need not start at the beginning of the sequence since the
track starts wherever you play the first note.

Warranty and Trademark Information:

Unless otherwise noted, the term 'Chroma' refers to any one of the synthesizers in the Chroma product line (currently Chroma, Chroma Expander, and Chroma Polaris).

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The Chroma interface hardware and Sequencer software were designed by Tony Williams. This manual was written December 10, 1982 by Tony Williams. A major revision (Rev 5) of the software and manual was completed on January 24, 1984. Another major revision (Rev 6) was completed on August 19, 1985.

The author would like to express gratitude to Ken Ypparila for writing the excellent Arpeggiator, Multi-Instruments, Parameter Display, Copy/Merge Editor, and Quantizer overlays included in this revision.

INSTALLATION OF THE SEQUENCER KIT

Equipment Requirements:

   To put the system together you need the following:

      -a Chroma, Chroma Expander, or Chroma Polaris. Up to
         two (2) instruments can be connected to the
         system.

      -an Apple II Plus or IIe computer with 3.3 DOS with a
         16K RAM Card (Microsoft RAM card or Apple Language
         Card or other compatible RAM card), one or two
         disk drives (although two drives is recommended),
         and a CRT monitor. The 16K RAM card is not
         required if you have an Apple IIe computer.
         Serious limitations arise from having only one
         drive (see Chapter 1). In future revisions, we
         may require two drives, so it is highly
         recommended that you start with two.

      -a Chroma Computer Interface Kit, which consists of the
         printed circuit (PC) card, the interface cable,
         the phono jack box and mounting plate, footswitch,
         Sequencer Program diskette, Sequencer Data
         diskette, and the Sequencer Manual.

      -options include another interface cable for
         controlling more than one synthesizer and a
         control pedal for speed changing. A Chroma
         Computer Interface Manual is also available, which
         describes interfacing to the Chroma in general.

      -also optional is an expanded RAM card (not sold by
         Fender), to be installed according to the card
         manufacturer's instructions.

How To Install It:

   The following installation steps should first be read
completely, then performed in succession. If you need to install
the interface PC card in a slot other than 5 see Appendix G
before installation. This procedure assumes the computer and its
required peripherals and PC cards are completely installed and
functional. If you have any problems with installing these
devices, please consult your computer dealer.

   1.Turn the power OFF both the computer and the synthesizers.

2. Open the top cover of the computer.

3. Take the connector box with the mounting plate loosely attached and slip it onto the back of the computer. Orient the box such that the cables slide in the second cutout from the left and the screws in the mounting plate are in the leftmost cutout. If you are using an Apple IIe, the cables cannot be slid into the cutout, they have to be threaded through a rectangular hole in the back of the computer. Otherwise, the mounting method is the same. Tighten the screws in the mounting plate firmly (you may want to remove your 16K RAM card from slot 0 to do this).

   CAUTION: Do not tighten the plate mounting screws unless the connector box is mounted to the rear of the computer. This may cause the screw to damage the wiring inside the connector box. FOR GROUNDING SAFETY, YOU MUST MOUNT THE CONNECTOR BOX TO THE COMPUTER CHASSIS.

4. Orient the Interface PC card as it will fit into SLOT 5 of the computer PC board. Before actually inserting it in the slot, connect the round phono-jack cable assembly from the box onto its wafer pin mate on the Interface PC card. Match pin 1 on the cable assembly connector to the TOP pin of the wafer connector. When it is properly connected, the metal pins in the female connector will be visible from the component side of the interface PC board.

5. Next connect the ribbon cable from the Chroma port to the TOP 26 pin connector on the Interface PC card. The Chroma port cable is the leftmost ribbon coming out of the slot in the connector box. Then connect the Expander port ribbon cable to the BOTTOM 26 pin connector on the Interface PC card. Then finally, slowly insert the PC card in SLOT 5 of the computer's main PC board.

6. Since it is not recommended that you have unnecessary current drawn from the computer power supply, you should remove any peripheral cards that you will not need with this system. You will, of course, need the RAM card and the disk controller card. If you have an expansion RAM card, you should also install it at this time. See the manuals for each of these boards regarding specific installation procedures. See RECONFIGURE (Chapter 9) about configuring the software for any expansion RAM.

7. Replace the top cover of your computer.

8.Connect one end of the large external computer cable to
  the COMPUTER INTERFACE (or CHROMA INTERFACE) connector on
  your main synthesizer (the one you will record with). The
  other end of the cable should be connected to the CHROMA
  connector on the interface connector box. It does not
  matter which end goes to the synthesizer. If you have
  another synthesizer, install the optional cable between
  the COMPUTER INTERFACE connector on this synthesizer and
  the EXPANDER connector on the interface connector box.

9.Plug the footswitch plug into the connector box jack that
  is marked FOOTSW and (if you have one) the control pedal
  plug into the jack marked PEDAL. If you want to use the
  system without a footswitch see the RECONFIGURE section
  (Chapter 9) of this manual. This is important since the
  system will not play sequences unless the footswitch is
  plugged in or unless RECONFIGURE has been setup to ignore
  the footswitch.

10.Connect your own 1/4" phone audio cable between the CLICK
   jack on the connector box and a high impedance input to an
   amplifier or mixer. Input impedance to the amplifier
   should be at least 100K ohms.

11.Follow the power up procedure outlined below.

Power Up Procedure:

1.Turn on the synthesizers first.

2.Insert the Sequencer Program diskette in Drive 1 of the
  computer. If you are using two drives, insert the
  Sequencer Data diskette in Drive 2.

3.Turn on the computer and the CRT monitor. If you have a
  Chroma or Chroma Expander connected to either port, you
  should wait until the Auto-Tune LEDs stop flashing before
  turning on the computer.

4.A message will appear indicating that the system is
  initializing. Once it has determined that there is a
  synthesizer connected, it will display a message
  indicating that the synthesizers are "ON LINE...". If the
  system has been configured for expansion RAM, a message
  will appear indicating how much RAM was installed.

NOTE: If you have configured the system for expanded RAM
(see Appendix F) and you do not see the installation
message, either you have not exactly followed the expanded
RAM installation procedure or the RAM card is not in the
slot specified.

NOTE: If the synthesizer connected to the Chroma port is
not responding, the computer will tell you so by beeping
and displaying "CHROMA PORT NOT RESPONDING!" If this
happens you should check the cabling, reset the
synthesizer (see the synthesizer's manual) then type any
key on the computer keyboard. If this does not fix the
problem then power down the computer, reset the
synthesizer, then turn on the computer again. If you are
still having problems, follow the steps outlined in this
chapter from scratch. If all else fails call the Fender
Service Department.

5.If you are powering up for the very first time, go to
   RECONFIGURE (Chapter 9) to change the number of drives,
   change the interface slot number, install the expanded
   RAM, or disconnect the footswitch. Then save the
   RECONFIGURE setup under the name of MAIN SETUP and reboot
   (type PR#n, where n is the slot containing the disk
   controller PC card).

THE MAIN MENU

This chapter describes the three pages of main menu selections. Each of the entries represent functions that can be selected by pressing the appropriate key on the APPLE keyboard. These are single key entry selections; in other words, a <RET> should not be depressed after the letter. Any of the selections on all three pages can be accessed no matter which page is being displayed. The ^ symbol means that the "CONTROL" or <CTRL> key must be held down at the same time as the regular key. For example to select the speed change mode (^T-SPEED CHANGE), you would hold the <CTRL> key down and press T on the APPLE keyboard.

Some of the selections from the main menu invoke other menus or questions from the Sequencer. Other selections are switch functions, so pressing their key toggles a condition. Several functions have no meaning if there is not a sequence in memory (such as P-PLAY SEQ) so pressing that key does nothing and returns to the main menu. If you press two keys, one right after the other (counting CTRL operations as one key), the sequencer will remember the second key and apply it as the next selection. This "type ahead" feature allows fast key entry but you must be a little more careful when you make a selection. Do not be afraid to experiment since anything that can destroy data directly from the main menu has second chance features built-in.

The first page of the menu has special significance because it is the page that is always returned to after any operation and because it contains important information regarding the status of the various functions. The Memory Usage is displayed at the top of the menu. It is an approximate percentage of the total memory that is used by the sequence currently residing in RAM. If there is an inverse video space (square white spot) after "G-GET SEQ" then there is a sequence currently in RAM. When the system is first powered up the Memory Usage is 0% and there is no inverse space at GEQ SEQ because a sequence has not yet been loaded. Another example of information displayed is the inverse video section after "K-Click Track" which tells the user the status of the click track. The status of all the functions displayed on page one of the main menu are described in detail in the sections of this manual dealing with those particular functions.

If the CRT screen blanks all of a sudden while on page one of the main menu, there is nothing wrong; the Sequencer is just blanking the display so CRT damage will not occur if the system is left unattended for an extended period of time. To restore the display, hit any key. This key will not be decoded as a menu selection. Screen blanking occurs only when page one (1) of the main menu is being displayed.

Description of Menu Selections:

G - GET SEQUENCE from diskette. See Chapter 7.

S - SAVE SEQUENCE onto diskette. See Chapter 7.

P - PLAY SEQUENCE (plays unmuted tracks). See Chapter 4.

W - PLAY ALONG (same as PLAY SEQUENCE but reserves instrument 0 and 1 (if link) for the keyboard connected to the Chroma port). See Chapter 4.

N - SET ENDPOINTS (measure) for PLAY SEQUENCE, RECORD TRACK, in or out of LOOP mode. See Chapter 4.

R - RECORD TRACK (records a track, two tracks if program has a link, three tracks if a Polaris is connected and its sequence is playing). See Chapter 5.

A - AUTO SAVE SWITCH (if ON then the Sequencer automatically saves the sequence, with a rename option, at the end of each RECORD TRACK operation). See Chapter 5.

T - TRACK DIRECTORY (displays recorded tracks and provides useful information such as the name of the track, the port to which it is assigned (Chroma or Expander), the name of the instrument on that port, its voice program number, and the initial volume of the track). See Chapter 6.

M - MUTE or UNMUTE a track or all tracks. See Chapter 6.

L - LOOP SWITCH (if ON then the Sequencer loops between ENDPOINTS. This allows PLAY ALONG during RECORD TRACK mode until cued for recording). See Chapters 4 and 5.

K - set up CLICK TRACK. See Chapters 5 and 8.

B - EDIT (allows user to do simple editing on a track(s)). See Chapter 6.

I - REINITIALIZE the Apple, the synthesizers on the Chroma and Expander ports, if present. This should be used only if communication problems arises. See Chapter 11.

D - DELETE a sequence from the diskette. See Chapter 7.

E - CHANGE PROGRAM (the sound) of a track(s). See Chapter 6.

C - CLEAR sequence from Apple memory. See Chapter 5.

F - CATALOG (displays a list of all music related files on the diskette, such as sequences, program groups, special data) See Chapter 7.

Z - ZAP A TRACK (deletes a track(s) from the sequence in Apple memory). See Chapter 6.

Q - PROGRAM FILE MANAGEMENT. This allows you to transfer program groups to and from the Chroma port, Expander port, and Disk. It also allows deletion of program groups from disk. See Chapter 7.

V - CHANGE VOLUME of a track(s) overall. See Chapter 6.

X - RECONFIGURE. This allows the user to install expanded RAM, disconnect the footswitch, connect the SYNC INPUT, set up an external clock, change the slot locations of the Interface Card, or disable the emphasis on the first beat of the measure in the click track. It also allows the user to view the current status of the system. See Chapter 9.

H - CHROMA<>EXPANDER. Allows direct communication between the Chroma and the Expander ports. See Chapter 11.

U - PARAMETERS. Displays the numerical value of the program parameters of the Chroma or Chroma Expander connected to the Chroma port. The Polaris is not supported in this selection. See Chapter 11.

J - ARPEGGIATOR. Allows external clock syncing of arpeggiation patterns entered via the Chroma keyboard. See Chapter 10.

Y - POLARIS SEQ management. Allows the saving, loading, deleting, and cataloging of Polaris sequence data files (similar to program group file management). See Chapter 7.

<RET> - Main Menu   <ESC> - EXIT to Applesoft

  2 - Menu Page Two   3 - Menu Page Three

^W - PRESSURE RECORD. Allows the recording of pressure data from the Chroma port (works on REV 3+ Chromas with pressure sensor option only). NOTE: This command is not displayed in the menu. See Chapter 5.

^U - UTILITY BANK 1. Runs one of up to 10 user written program overlays (as an example we have included a comment program and an ECHO program). See Appendix C.

^V - UTILITY BANK 2. Runs one of up to 10 more user written
     program overlays, if available (as an example we have
     included a complete hardware test program).   See Appendix C.

^X - DELETE all MEASURE commands. It contains a second chance
     verification. NOTE: This command is not displayed in the
     menu. See Chapter 11.

^Y - SCRUNCH the sequence (reduce timing resolution of the
     sequence in memory and save approximately 6% of the storage
     space).   See Chapter 11.

^T - Selects SPEED CHANGE mode. Selecting this toggles
     between OFF, SMALL, and LARGE time variations. The
     large speed change mode varies the playback speed of
     the sequence from 1/2 speed to 2 times normal speed
     continuously with the pedal.   The small speed change
     mode does the same except within a more restricted
     range. See Chapter 6.

^S - STORES the speed change as you here it if ON and in PLAY
     mode or OFF and in RECORD mode.   See Chapter 6.

^A - TRANSPOSE sequence or track.   See Chapter 6.

^N - RENAME a track(s).   See Chapter 6.

^P - CHANGE PORT from Chroma to Expander or vice versa. See
     Chapter 6.

^I - INSTRUMENTS.   Allows the user to play multiple instruments
     from the Chroma keyboard.   See Chapter 11.

^E - COPY/MERGE editor. Allows the user to copy, merge, and
     replace tracks. It allows a primitive form of punch-in/out
     editing capability via track replacement. See Chapter 6.

^Q - QUANTIZER. Allows quantization, or time correction, of a
     track(s) between two endpoints to a selectable resolution.
     See Chapter 6.

Sequencer Menu Quick Reference:

Page 1:

G - GET SEQ	S - SAVE SEQ
R - RECORD TRACK	P - PLAY SEQ
N - ENDPOINTS	W - PLAY ALONG
A - AUTO SAVE SW	^T - SPEED CHANGE
L - LOOP SWITCH	^S - STORE SPEED
K - CLICK TRACK	
2 - MENU PAGE TWO	3 - MENU PAGE THREE

Page 2:

M - MUTE/UNMUTE	F - DISK CATALOG
T - TRACK DIRECTORY	Q - PROGRAM FILES
C - CLEAR SEQ	B - EDIT SEQ
Z - ZAP TRACK	E - CHANGE PROGRAM
^N - RENAME TRACK	V - CHANGE VOLUME
^Y - SCRUNCH	^A - TRANSPOSE
<RET> - MAIN MENU	^E - COPY/MERGE

Page 3:

D - DELETE SEQ	^I - INSTRUMENTS
^P - CHANGE PORT	I - REINITIALIZE
X - RECONFIGURE	^U - UTILITY BANK 1
J - ARPEGGIATOR	U - PARAMETERS
H - CHROMA <> EXPAND	^V - UTILITY BANK 2
<ESC> - EXIT TO FP	Y - POLARIS SEQ
<RET> - MAIN MENU	^Q - QUANTIZER

Selections Not Displayed In Menu:

^X - DELETE MEASURES
^W - PRESSURE RECORD

PLAYING SEQUENCES

This section explains how to play one of the sample sequences provided with the system or one of your own sequences. It also explains details of looping and setting endpoints.

Before you load your first sequence it is a good idea to get familiar with the disk catalog selection. You should read about the disk catalog in Chapter 7 of this manual.

If you want to play using an external clock, read this chapter, then read Chapter 10 before proceeding.

How To Load A Sequence:

This section tells you how to load any one of the sample sequences included on the data diskette supplied with the Interface Kit. This same procedure is to be used to load YOUR sequences once you have saved them onto disk.

When you are in the main menu, look at 'G-GET SEQ'. If there is an inverse video space after this menu entry then there is already a sequence in memory and it will be written over (lost) if you load another. See Chapter 7, Disk Functions, to learn how to save a sequence if you want to keep this one.

After typing G for GET SEQ, the sequencer will ask you if you want to see the disk catalog. Type Y if you do, any other key if you don't. After the catalog routine is done, as described in Chapter 7, the Sequencer will ask you for the name of the sequence to be loaded. If you change your mind at this point, just type <RET> and you will get back to page one of the main menu without loading the sequence. Otherwise, type in the name of the sequence then <RET>. If all goes well (meaning that the file was found, etc.), the Sequencer will tell you that the sequence was loaded and will display page one of the main menu.

Playing Sequences:

To play a sequence, all that is required is to type P. If the sequence currently in RAM does not play and the Sequencer immediately returns to the main menu, it is likely that the footswitch is not plugged in the connector box (see Chapter 2 for proper installation).

If you are using the Sequencer in a live performance situation and want to start the sequence at an exact point in time, you should read Chapter 9, Reconfigure, regarding the use of the SYNC input with a footswitch.

NOTE: Some of the sample sequences contain tracks that are designated for output to the Expander port. If you play these sequences unaltered and there is no Expander on line, the Sequencer will tell you and automatically mute the track. To eliminate this problem, change the port to Chroma and unmute the track(s) as described in Chapter 6. Then save the modified sequence as described in Chapter 7.

NOTE: The measure display in the lower left corner of the CRT will increment if the sequence was recorded with a click track or external clock. The display is used for general reference, for determining endpoints, and when using the Editor (see Chapter 6). If the Time Increment is other than 1X (see Chapter 9), the measure numbers displayed are inaccurate.

Play Along:

When playing a sequence you have a choice of "P-PLAY SEQ" or "W-PLAY ALONG". PLAY ALONG reserves instrument 0 for the keyboard on the Chroma port, whereas PLAY SEQ defines the first track encountered as instrument 0. What this means is that under PLAY SEQ any lever changes, etc. that you do on the synthesizer while the sequence is playing will be heard affecting the first track encountered and any notes you play on the synthesizer keyboard will use channels that the first track would normally have available for its notes. Also, if you press a voice selection switch on the synthesizer, that first track will change voices. In other words, the first track and what you do on the synthesizer "shares" instrument 0. Under PLAY ALONG what you do on the synthesizer is reserved for just that and the first track uses another instrument. The "first track encountered" does not necessarily refer to track number 1. The concept of tracks, instruments and channels is further explained in Appendix H.
       If you intend to change to a linked program during PLAY ALONG, you should always begin with a linked program. If you do not, you will temporarily change the sound of a track when changing from a non-linked program to a linked-program, and temporarily silence that track when changing back to a non-linked program. The reason for this is that the Sequencer determines which 'instruments' to reserve for the keyboard depending on the link status of the current selected program at the time of play. If you change that status, you will effect the sequence playback. The solution, as described above, starts the playback with the maximum number of instruments reserved for the keyboard and allows you maximum freedom in PLAY ALONG program selection.

PLAY ALONG does not reserve instruments in the synthesizer connected to the Expander port (it is assumed that this port does not have a keyboard). So, if the instrument connected to the Expander port has a keyboard, anything played on this keyboard will share instrument 0 with the first track sent to this port. In other words, there is no PLAY ALONG in regard to the Expander port.

Stopping The Sequence:

Whether in PLAY SEQ or PLAY ALONG, you can let the sequence play to the end or type a space or depress the footswitch to stop. If the footswitch has been disconnected via RECONFIGURE (see Chapter 9), depressing it will have no effect and the sequence will continue to play. Regardless of the way the sequence is stopped, the main menu will reappear with the "LAST EVENT TIME: XXXXX" message above it. This is useful when editing a sequence so, for now, disregard it.

Looping:

What if you want the sequence to play over and over again? To do this type L to toggle the LOOP SWITCH. Now if you play the sequence it will loop continuously until you press the space bar or tap the footswitch. When you stop the sequence the LOOP SWITCH is automatically turned off. Whether the sequence loops in time depends on the way it was recorded and whether there was a click track when it was recorded. See the sections regarding RECORDING and the CLICK TRACK for more details about loop time.

Endpoints:

What if you want to start the sequence at a point other than the beginning or end the sequence at a point other than the end? The Sequencer can use measures to define endpoints in the sequence. If the sequence was recorded with a click track or with an external clock, measures were automatically recorded in the sequence for reference. If the sequence you currently have in memory was recorded with a click track, the inverse video section after the selection "K-CLICK TRACK" on page one of the main menu will say "OFF 60BPM 4/4" or something similar. If it was recorded with an external clock, the menu will display "EXT 24 CLKS/BEAT 4/4" or something similar. If it was recorded without a click track or external clock the inverse video section will say "NONE", in which case you cannot set up endpoints because there are no measures. If there was a click track or external clock, type 'N-ENDPOINTS' to set up the beginning and ending endpoints.

When you select ENDPOINTS, the Sequencer displays the total number of measures stored during the recording (actually the number of the last measure stored) and the current endpoints. If the number of measures stored is zero then either the sequence was recorded without a click track, without an external clock, or the person that recorded it deleted all the measures to save memory (see Appendix E, GETTING MORE NOTES OUT OF THE SYSTEM). If the current endpoints are "B-E" then the sequence would start playing at the beginning and end at the end, regardless of measures.

To set the beginning endpoint type B then type the number of the measure from which you want to start, followed by a <RET>. To set the ending endpoint type E then type the number of the measure at which you want to stop, followed by a <RET>. If you try to change either endpoint to an illegal measure number (such as 0) then no change in the endpoints will occur. If you try to change to a number greater than the total measures stored, then the ending endpoints will be set to E. Type a <RET> to get back to the main menu after setting the endpoints.

Playing And Looping Between Endpoints:

When you PLAY SEQ now, the sequencer will play, starting at the beginning measure and stopping at the ending measure set by the endpoints. If you now select LOOP mode by toggling the loop switch, the sequencer will play between the endpoints continuously until stopped. The loop time may be increased by one measure due to the increased processing time required to find the beginning and ending endpoints.

RECORDING SEQUENCES

    This section will explain the operations required to record
a clean slate (the first track) and subsequent tracks. If you
want to record using an external clock, read this chapter then
read Chapter 10 before proceeding.
    Before recording the first track of a sequence it is
essential that the RAM be cleared. Therefore, this section will
start with an explanation of C-CLEAR SEQUENCE.

Clearing a Sequence:

    Selecting this menu function initializes the Sequencer to
begin recording. The Sequencer allows you to abort this command,
as with all commands that will cause loss of valuable data.
During this selection the RAM is cleared and the click track is
turned off. The Memory Usage will obviously be zeroed and the G-
GET SEQ menu entry will indicate that no sequence is in memory.

Setting Up a Click Track:

    The click track is not really a "track" in a normal sense
but a hardware/software output pulse that is controlled by the
timer and various conditions set by you. The information
supplied is used for many other timing related operations such as
loop time determination, measure command storage and endpoint
references. It is, therefore, highly recommended that you start
recording a sequence with a click track (see Chapter 8).
    Do not use a click track if you have a drum machine and are
configured for external clocking (see Chapter 10). Measure
commands will be stored automatically when either a click track
or an external clock is used.

Auto Save:

    Before you begin recording you should know about the AUTO
SAVE function. If the AUTO SAVE SWITCH is ON, the Sequencer will
enter the SAVE SEQ mode at the end of every record operation.
This means that the Sequencer will display the current name of
the sequence and ask if you want to rename it. If you want to
abort the AUTO SAVE function, type <ESC> at this point (as in the
case of the normal SAVE SEQ operation). If you do not type Y (or
<ESC>) the Sequencer will save the sequence at the current name.
    The AUTO SAVE function is useful for saving different
versions of a sequence as you build it track by track. It is
suggested that you turn the AUTO SAVE switch ON until you become
familar with the Sequencer.

    Presently, the AUTO SAVE function is OFF when powered-up.

You can change this by modifying the main Sequencer program
RECORD TRACK.1. Before attempting this make sure any sequence is
saved, then while in the main menu type <ESC> to escape to FP
BASIC. Then type 105 AS%=0 then type <RET>. Next, type SAVE
RECORD TRACK.1 then <RET>. Keep in mind that the modification
should be done on a backup diskette, not the original and that
any diskette write protect tab should be removed prior to
attempting to save the program. Once the modification is
performed and the altered program is saved, you should reboot the
computer.

Recording a Clean Slate:

     After the the RAM has been cleared, the click track set up
and the AUTO SAVE switch is set at the desired state you are
ready to record the first track.
     Type R for RECORD TRACK and the Sequencer will ask you to
select a program on the synthesizer connected to the Chroma port.
Although you can change the program of a track very easily after
it is recorded, it is a good idea to select a program that at
least approximates what you will eventually want. This is
because the sound of that program will influence your phrasing
and other aspects of the music.
     After you select a program, press any key to tell the
computer you are ready. You can abort the record operation at
this point by pressing <ESC>. Any other key will cause the
Sequencer to continue in RECORD mode.
     When recording from a clean slate, the name of the sequence
will not exist. Just keep in mind that the SAVE SEQ function
will require you to name the sequence before saving (see Chapter
7).
     After the above program selection is completed, the
Sequencer will display how many tracks are being recorded and
their track numbers, track names, and program numbers. At this
point, you should notice that there may be a link to be recorded
along with the main. There may also be a Polaris internal
sequence to be recorded (details further in this chapter).
     The main track name will be set to 'Tn' where n is the track
number. If a link is being recorded, that track's name will be
'Tn.L', where n is the main track number. If there is a Polaris
sequence defined, that track's name will be 'Tn.S'. You can
change the name of any track later by using the ^N-RENAME menu
selection (see Chapter 6, EDITING SEQUENCES).

     The Sequencer will then tell you to:

PRESS ANY KEY OR THE FOOTSWITCH TO BEGIN RECORDING...
PRESS ANY KEY OR THE FOOTSWITCH TO END RECORDING...

When you press either the footswitch or any key on the computer keyboard, the inverse video RECORDING... message will be displayed. At this point the Sequencer is waiting for you to play. The track does not start and memory is not being used up until you start playing, move a performance control, or change the synthesizer program.

In the lower left corner of the display, the measure counter will increment while waiting for the first event. If you wait more than one measure before recording, the measure display will be inaccurate. This is corrected automatically on playback or when recording the next track. In other words, the first event is put in the first measure, regardless of the measure display while recording the first track. If the Time Increment is a value other than 1X (see Chapter 9), the measure display will be inaccurate.

Whenever a program is changed during the record operation (by pressing a program selection switch on the Chroma), you will create another track (two tracks if the program you select has a link). The Sequencer will detect this, set up the track and give it a name of 'Tn', as above.

The Sequencer can record up to 16 tracks but the Chroma can only play 8 tracks at a time. Changing programs while in the record mode is an easy way to concatenate tracks, insuring that there is no overlap. This allows you to use all 16 tracks even if you do not have two synthesizers.

When you are through recording the track(s), press any key on the computer keyboard or depress the footswitch. If the AUTO SAVE switch is ON you will enter the SAVE SEQ mode as decribed in Chapter 7. If you do not want to save the sequence, you should press <ESC> when asked if you want to rename the sequence.

Recording Subsequent Tracks:

To record subsequent tracks you basically follow the same procedure as for a clean slate. Prior to recording these tracks, you may want to turn off the Click Track, so see Chapter 8, THE CLICK TRACK. You may want to adjust the volume or mute certain tracks to enable you to hear the beat more easily (see Chapter 6, EDITING SEQUENCES). You may want to send certain tracks to the Expander port (see Chapter 6) so you have more notes available on your main synthesizer while recording the next tracks, etc.

Recording At Slower Speeds:

You may want to record at a slow speed to enable you to play difficult passages.

At Half Speed:

If you record at half speed, the recording will double in speed on playback. This is very easy to do using one of three methods. The first involves using the speed changing pedal, but this should be done after you are completely through with the sequence since the click track will no longer be in sync with the music if you do it this way.

The second way is much better. This involves the use of the RECONFIGURE selection described in Chapter 9. Basically, you want to set the TIMER INCREMENT to 1/2X before recording, then change it to 1X for playing. The final timer increment will be saved with the sequence and the click track will still be in sync. The only problems with this approach are that you can only change the timer increment in powers of two (1/16, 1/8, 1/4, 1/2, 1, 2, 4 and 8) and the measure display during recording and playback will be wrong (although consistent). As mentioned in Chapter 9, this feature was designed mainly to scale the clock frequency when converting between internal and external clocks.

The third (and probably best) way is to record normally with a click track at a slow BPM, then change the BPM rate to twice the previous value. This has the advantages of keeping the click track in sync and allowing the measure commands to retain their placement in the music.

At Other Speeds:

Changing the BPM after recording, as mentioned above, is probably the best way to change the playback speed.

You can record at any reduced speed using the SPEED CHANGE selection from the main menu, as long as you are willing to live without a click track. This gives you the added benefit of being able to change only sections of the music.

In record mode, the speed variation will be stored if the STORE SPEED switch is OFF. The reason for this is that the Sequencer determines the speed stored as the ratio of a variable to a fixed increment timer. You do not have to understand this to make the thing work. Just remember that the STORE SPEED switch works backwards in record mode, should you ever want to use it this way. It is probably more straight forward to use the STORE SPEED function during playback.

Recording With Pressure:

Since pressure recording requires a high data rate and uses a lot of memory, we have separated the record mode into two types: recording with pressure and recording without pressure.

To record with pressure, select ^W for PRESSURE RECORD and proceed as normal. This menu selection is not displayed in the main menu, but is available as if it were.

If the instrument on the Chroma port does not send pressure information, or it does but you want to save note memory, you should use the normal record mode.

Loop Recording:

This method of recording essentially allows you to play along in loop mode, then easily tell the Sequencer when you have the passage practiced enough to record it. Once the Sequencer has been "cued", the next loop automatically switches it to record mode.

First, turn ON the loop switch by pressing L, then go through the normal record procedures. When you press the space bar or footswitch to RECORD, the Sequencer will display "LOOPING...". Keep playing along with the sequence until you think you are ready to record, then press the footswitch. The Sequencer will then display "CUED...". The next time the sequence loops, you will be in record mode and the Sequencer will display "RECORDING...". The sequence will stop and the record mode will be terminated when you press the footswitch again, you press the space bar or the end of the sequence is reached. It is not possible to increase the length of the sequence when recording in loop mode.

Recording Polaris Sequences:

If a Chroma Polaris is connected to the Chroma port, it is possible to record a Polaris' internal sequence onto a Model 1611 Sequencer track. This section tells you how to do this, as well as how to send a track back to the Polaris to be recorded into one of its 12 internal sequences. These capabilities allow the Polaris sequence to take advantage of the editing capabilities of the Model 1611 Sequencer (i.e. Quantizing, etc.) and vice versa (i.e. accurate looping, segmenting the music, etc.).

The following paragraphs describe how to record a Polaris sequence. The uninitiated user should first make sure the Polaris Chroma Program Switch (LF, C, 5) and the Chroma Panel Switch (LF, C, 7) are off. The significance of this will become apparent later.

When going into record mode, select a Polaris sequence and depress the Polaris PLAY switch once (the metronome must stay off) as well as normally selecting the program. When the Sequencer displays the track names and programs set up to record on the various tracks, it will tell you that one of the tracks is a Polaris sequence (it will have a track name of `Tn.S' where `n' is the main instrument's track number). At this point depress a space or the footswitch to start recording as normal. You can then begin playing the keyboard at any time, and/or depress the Polaris TEMPO-TAP footswitch once (or the Polaris PLAY switch a second time) to activate the Polaris metronome. Turning on the metronome will start sending the Polaris sequence over the Chroma port.

You can stop the Polaris sequence at any time and continue the recording operation from the Polaris keyboard. You can even start another Polaris sequence after stopping the first one. The Polaris sequence queuing function will also work as expected. You can even sync the playback to a drum machine or MIDI (this same drum sync signal should be going to the EXT CLK input of the Model 1611 connector box while transferring the sequence).

If you do not play on the Polaris keyboard or if you did, but you do not want to save it, you should zap the main track after terminating the record operation. If you do this, use the Copy/Merge facility for reclaiming the track number (see Chapter 6).

The Model 1611 Sequencer knows the instruments connected to its ports and knows when you are recording a Polaris sequence. The Sequencer has to handle this recording operation differently than a normal record operation because the Polaris simulates a program change at the beginning of every loop of its internal sequence (even if the sequence is chained to itself). Unless the Model 1611 Sequencer ignored these program changes, a new track would be created for every loop of the Polaris sequence.

There will be times, however, when you will want to create new tracks from program changes: a) when the Polaris sequence chains to an entirely different sequence with a different sound, or b) when you want to change programs manually on the Polaris. To do these things, you must manually turn on the Chroma Program Switch (Lower Function C 5) or the Chroma Panel Switch (Lower Function C 7) _after_ going into record mode but _prior_ to the beginning of the new sequence chain or _prior_ to depressing the program selection manually. You can then turn the Chroma Program or Panel Switch off before the next Polaris sequence chain. As an alternative, you can turn on the Chroma Panel or Program Switch just before playing in record mode, and then turn them off at an appropriate point during the record operation for maximum control over when a new track is created.

It is also possible to send data from the Model 1611 Sequencer to the Polaris to be recorded into one of the 12 sequence spaces. This data could be a soloed track (see Chapter 6). If the Polaris is connected to the Expander port, this data could also come from the H-CHROMA:EXPANDER selection (see Chapter 11) or the Arpeggiator (see Chapter 10).

To do this, just put the Polaris into record mode and start the metronome. Then play the soloed track or the keyboard of the instrument on the Chroma port. The Model 1611 sequence track must be soloed to force it to be sent as instrument 0 (main instrument) data.

When the Polaris sequencer is recording, it uses the last event to determine its loop point. This last event is discarded; you will never hear it. Therefore, the source of the transferred data (be it a soloed track or other data) must have this loop determining event added to its end.

If the data is a soloed track that was recorded from a keyboard, it is easy to add a 'stinger' to the end while recording. If the soloed track was recorded from a Polaris sequence, you will need to add the stinger by another method. One method is to add an ATTACK command by using the Editor (see Chapter 6). An easier method is to record a separate track from a keyboard that consists of only the stinger (at the correct time) and use the Copy/Merge editor to merge the two tracks into one (see Chapter 6) before sending it to the Polaris.

EDITING SEQUENCES

This section deals with the many ways to edit your sequence once you have recorded it. Editing functions fall into three catagories: miscellaneous track directory functions, speed changing, quantizing, and the Editor.

Miscellaneous Track Directory Functions:

These functions are grouped together because they all involve using and/or modifying the sequence track directory.

Track Directory:

The track directory is a list of all the tracks that make up a sequence. Included in each track entry is the following vital information:

-track number- This is the number to use whenever you want to refer to a particular track.

-track name- This is currently for your use only. The Sequencer does not refer to this name except to generate default names during recording. The name must follow the syntax rules outlined in APPENDIX P.

-track port- This is 'C' if the track is to be outputted to the Chroma port or 'X' if the track is to be outputted to the Expander port.

-track instrument- This is the name of the instrument connected to the port. If the port is off line, "********" is displayed.

-track program- This is the program for the track, displayed in the notation of the instrument connected to the port (B1 for Polaris, 13 for Chroma or Chroma Expander).

-track volume- This is the initial linear volume value for the track.

Change Port:

    This routine begins by displaying a track directory and
prompting you for the track number.   After you input the track
number, the Sequencer will toggle that track's port and redisplay
the track directory. If the track was destined for the Chroma,
it will now be set for the Expander, whether there is an Expander
on line or not. During playback, if there is no Expander, the
Sequencer will tell you and mute that track. If this happens,
change the port back to Chroma and unmute the track as described
later in this chapter (under MUTE/UNMUTE). If the track's old
port was connected to a Polaris and the new port is connected to
a Chroma, the program number is truncated to 50.   If this
happens, the program field in the track directory entry will
display #50. The old number is retained internally; only the
port output and display is truncated. Changing the port back
will restore the original program selection. To exit the change
port mode, press <RET> when the Sequencer asks you for the track
number.

Change Program:

    This routine also begins by displaying a track directory and
prompting you for the track number.   After you input the track
number, the Sequencer will prompt you for the new program number.
If you change your mind and do not want to change this track,
press <RET> and the sequencer will redisplay the track directory
and ask for another track number to change. If you input the new
program number, the Sequencer will change that track's program
and redisplay the track directory.
    Program number input must be in the format of the panel of
the synthesizer connected to the track's port (i.e. Polaris input
B1, Chroma or Chroma Expander input 13). As a short cut, Polaris
input 1-12 is interpreted as A1-A12. To exit the change program
mode, press <RET> when the Sequencer asks you for the track
number.

Change Volume:

    This routine also begins by displaying a track directory and
prompting you for the track number.   After you input the track
number, the Sequencer will prompt you for the new initial volume
value. If you change your mind and do not want to change this
track, press <RET> and the Sequencer will redisplay the track
directory and ask you for another track number. If you input the
new initial volume value, the Sequencer will change the track
volume and redisplay the track directory. To exit the change
volume mode, press <RET> when the Sequencer asks for the track
number.

The volume value is linear, as mentioned above in the description of the track directory. The volume of the track may be varied at any time from the initial value by use of a pedal controlling the volume parameter of a program in the Chroma during recording or by inserting volume commands via the Editor. Volume commands can also come from the Chroma when you are recording a linked program (2 tracks at once) and you change the link balance (see APPENDIX K for a description of a small software bug in the Chroma). If either of these is the case, then changing the initial volume of the track will only effect the track up until that volume command is encountered. In other words, the volume values, initial or otherwise, are absolute, not relative.

Zap A Track:

This routine will delete a track from the sequence. It begins by displaying a track directory and prompting you for the track number. After you input the track number, the Sequencer will delete all commands that belong to that track then redisplay the track directory. To exit zap mode, press <RET> when the Sequencer asks you for the track number to delete.

If you zap the last track that was recorded, then that track number will be available for subsequent recording operations. If you zap a track other than the last one, that track number is not available for subsequent recordings. In other words, you effectively lose one of your 16 tracks and the tracks numbers will not be sequential. These tracks can be reclaimed by using the Copy/Merge Editor described later in this chapter.

NOTE: If you zap Track 1 and the sequence is externally synced, you will lose some of the syncing information (actually, you delete the TIME 0 command). To restore sync, you must run the User Utility Bank1, number 2 program by typing ^U then 2<RET>.

Rename A Track:

This routine allows you to change the name of a track. It also begins by displaying the track directory and prompting you for the track number. After you input the track number, the Sequencer will prompt you for the new name. The name must follow the syntax rules as outlined in APPENDIX P, but don't worry, the Sequencer will not let you input anything that is illegal. If you change your mind and do not want to change the name of this track , press <RET> at this time. If you input the new name, the Sequencer will change the name of the track and redisplay the track directory. To exit the change name mode, press <RET> when the Sequencer asks you for the track number.

Transpose:

    This routine allows you to transpose the whole sequence or
any one track in semitones. Maximum allowable transposition is
33 semitones at any one time, up or down. The Sequencer
currently does not check for cumulative transpositions, so care
must be taken that the total amount of transposition does not
exceed 33 semitones, else the Chroma will get confused and play
the wrong notes. Unfortunately, after the limit has been
passed, you cannot recover the sequence by transposing an equal
amount in the opposite direction.
    The routine begins by asking you if you want to transpose
all tracks. If you do, type A for all. If you want to transpose
one track, then type <RET>.
    If you type <RET> for single track transposition, the
Sequencer will display the track directory and prompt you for the
track number. If you type <RET> instead of the track number at
this point you will abort the transposition and exit back to the
main menu. If you type a track number, the Sequencer will then
ask you the amount to transpose. Type <RET> at this point to
abort the transposition and exit back to the main menu, otherwise
type in a semitone value preceeded by a + or - for direction. If
there is no direction symbol, the Sequencer will assume +
direction. If you input an invalid value, the Sequencer will
tell you and ask you to reenter the direction and transposition
amount. After the transposition is complete, the Sequencer will
return to the main menu.
    If you type A to transpose all, as presented above, the
Sequencer will ask you for the direction and amount of
transposition. Enter this value as if you were transposing only
one track as outlined above. The Sequencer will transpose all
tracks and return to the main menu.

Mute/Unmute:

    This routine allows you to mute and unmute tracks. A muted
track retains all of its information, but will not be heard
during playback. MUTE/UNMUTE has its own menu that allows you to
view the track directory, mute a track, solo a track, unmute a
track, or unmute all tracks. A track that is muted will be shown
in INVERSE VIDEO in the track directory (and the EDITOR) and will
not be outputted to it's port. To exit the Mute/Unmute mode,
press <RET> when the mute menu is displayed.
    A track may be automatically muted if it is designated for
the Expander port and there is no synthesizer on line. It will
also be automatically muted if you try to output more than the
following to the Chroma port:

-8 tracks if in PLAY mode,
-7 tracks if in PLAY ALONG mode (or when recording) with a
    non-linked program,
-6 tracks if in PLAY ALONG mode (or when recording) with a
    linked program, or
-5 tracks if recording a Polaris sequence (regardless of
    the link status).

If the AUTO-REROUTE flag is ON (see Chapter 9) and there is
a synthesizer on line at the Expander port, then you can add 8 to
every number mentioned above because up to 8 tracks will be
automatically rerouted to the Expander port. If the above limits
are violated (and AUTO-REROUTE is OFF and/or the Expander is off
line), the Sequencer will automatically mute the track that puts
it over the limit. A message will be displayed and the Sequencer
will continue to play/record.

To permanently unmute a track that the Sequencer
automatically mutes, you must correct the condition that caused
this to happen, then manually unmute the track via Mute/Unmute.
In other words, you must ZAP the track, ZAP another track, or
change the port of the track, then unmute it.

Copy/Merge Editor:

This selection performs track duplication and merging
functions. It helps you build layered sounds, reclaim track
numbers made inaccessible by certain invocations of the Zap Track
utility, and even perform some limited punch-in/out editing.
The three basic functions provided are:

           M - Merge two tracks
           P - Punch in a track (replace function)
           C - Copy a track
        <ESC> - Main menu

In all cases, the Track Directory is available by typing T
when asked to input the track number.

Merge combines the data from one track (the mergor) into
another track (the mergee). It will concatenate two tracks if
the mergee ends before the mergor begins. The track number of
the mergor will be freed and its data becomes part of the mergee.
This function allows you to record a piece a section at a time
and then combine the sections into a track. It also allows you
to add notes to the middle of an existing track without using a
separate track number.

Punch-in replaces the data from the corrected track (the replacor) into the track being edited (the replacee). Any data in the replacee occurring between the first and last event in the replacor will be erased. Only those replacee notes actually held down at the beginning of the replacor track are released; a general track squelching does not occur. The track number of the replacor is freed. This function allows you to easily fix recording errors.

Copy duplicates an entire track to the lowest available track number. This allows you to free tracks made inaccessible by certain invocations of the Zap Track utility. You can do this by copying into the inaccessible track, then deleting the original track via Zap.

In general, track numbers can be minimized by a series of merges, copies, and zaps.

Speed Changing:

You can change the speed of sequences four different ways:

(1) By using a variable external clock (see Chapter 10).

(2) By changing the time increment by powers of two (see Chapter 9, RECONFIGURE).

(3) By changing the click track BPM value (see Chapter 8).

or (4) By using the main menu selections ^T - SPEED CHANGE and ^S - STORE SPEED, which are described in this section of the manual.

Before using the SPEED CHANGE/STORE SPEED selection, make sure you have the optional control pedal connected to the PEDAL input of the connector box on the back of your computer. You can use the Chroma's pedal, purchase one from us, or use any 100K linear taper potentiometer (it doesn't have to be a pedal).

The analog-to-digital converter (ADC) IC on the Interface PC Card will convert the resistance of your pedal into a digital value that the Sequencer will use to change the speed of the sequence. If you suspect that the range of the ADC is out of adjustment, run the ADC Test Program in USER UTILITY BANK 2, number 1 or the Interface Test Program in USER UTILITY BANK 2, number 0 (the command is ^A for ADC test in the Interface Test Program). Number 1 displays the value in decimal (0-255) while Number 0 displays it in HEX (00-FF). When you move the pedal to its extremes, the value displayed should go from 0 (pedal all the way up) to 255 or FF (pedal all the way down). If this is not the case, then you should adjust the ADC according to the procedure outlined in APPENDIX O, Hardware Description and Specifications.

The speed change selection ^T is a three way toggle switch,

which is either OFF, SM (small variation), or LRG (large variation). The large variation allows you to increase the speed up to twice normal or decrease it down to one-half normal. The small variation range is approximately one fourth of the large range. When either the small or large speed variation has been selected, the Sequencer will play back at a variable speed, depending on the position of the pedal.

In play mode, the speed change is not permanent unless the SPEED STORE switch is ON. In record mode, the speed change is not permanent unless the the SPEED STORE switch is OFF. This switch is a normal two position toggle switch. In the on position, the Sequencer changes the time values in the sequence to correspond to the variations in pedal position. When the switch is on, the sequence should be allowed to play all the way through, otherwise you will get timing glitches, or sudden changes in tempo, that are almost impossible to remove. If you want a sudden change in tempo, it is relatively easy to just move the pedal quickly.

A neat effect is to loop a small sequence with the SPEED CHANGE on large or small variation and the STORE SPEED on. Everytime the sequence loops, it is faster.

After the speed of a sequence has been permanently changed by STORE SPEED, the click will never again be in sync with the sequence. You should, therefore, change the speed of the sequence only after you no longer need the click track. The measure commands will be correct at the faster or slower speed because time values are stored with them, unlike the click track which is not really a track at all.

WARNING: Always turn OFF the SPEED STORE switch immediately after you permanently change the speed of the sequence. It does not automatically turn OFF. If you immediately play the new sequence to hear how it came out and the STORE SPEED switch is still ON, you will change the speed again.

Quantizing (Error Correcting):

This program quantizes, or time corrects, specific tracks in your sequence. It does so by shifting the notes forward or backward in time to match a variable resolution counter. The length of the note is not effected, only its placement in time. This is what makes the time correction sound so "human" even though the attacks are timed precisely.

The program works with either internal or external timer sources. These are selected, of course, in RECONFIGURE (see Chapter 9). If an internal clock is used, a click track must have been used to record the first track. The time signature denominator must be 2, 4, or 8 and the numerator between 1 and 15. This is required regardless of the timer source. With an internal clock and unusual time signatures, certain triplet figures cannot be quantized. For example, in 5/4 time quarter note triplets do not divide evenly into the measure whereas eigth note triplets would. The program detects this ahead of time and will not let you make this selection, but will display a message telling you why. This is not a problem with an external clock sequence because the clock is variable and the timebase allows for most triplet figures.

You have a choice between 1/4, 1/8, 1/16, or 1/32 note resolution in straight or triplet.

You quantize one track at a time and you specify between what two endpoints the program will quantize. This gives you maximum flexibility. For example, if the track's effective time signature changes midway, you can specify different quantizing resolutions. This assumes that the changes occur on a measure boundary (however, you can insert a measure command at any point via the Editor to fool the Quantizer). Also, this allows you to not quantize a measure if both triplets and straight notes are present.

When asked to specify the track number, you can get a Track Directory by typing T. Endpoints are specified in the same manner as in ENDPOINTS (see Chapter 4).

When quantizing pickup notes in an internal clock sequence, the program converts the pickup notes into a full measure. If the click track started on a beat other than the first of the measure, it will now start on the first beat before the first note is played. This creates a new first measure at the beginning of the sequence. All following measure numbers are increased by one to reflect this. In addition, any endpoints set are corrected.

Most of the time, quantizing several tracks will save memory by eliminating some time commands. If some should be added and the memory becomes full, the program will return with a message. In this case some notes will be lost and consequently the sequence will be ruined. If working with no memory to spare, be safe - make sure you have a copy of the sequence saved on disk before quantizing. Besides losing data because of memory full conditions, you may find that the sequence sounds worse after quantizing. Since this quantizing is post proceessing, you can not unquantize!

The Editor:

A sequence is organized as a list of musical events. Each event has a track number associated with it. The events for all tracks are, therefore, interleaved in the sequence. The events are represented by 'commands' (such as ATTACK, RELEASE, etc.) that can be altered by the Editor.

A track always begins with a DEFINE command and always ends with an UNDEFINE command. Between these two commands, Chroma 'channels' are allocated for that track (as detailed in APPENDIX H).

The Editor operates by displaying the next command entry from the EDIT TRACK LIST (list of tracks that you are currently editing) and prompts you for instruction by a ":" on the next screen line. Command entries from muted tracks will be displayed in inverse video. If you do not want to change this command entry, just press the space bar (NEXT) and that command will be restored in the sequence. If the MONITOR is on and the track is not muted, then the command entry will also be outputted to its port. The next command entry will then be displayed. The sequence cannot go backwards. The endpoints are set at the beginning and ending of the sequence while in the Editor, regardless of previous endpoint settings. The endpoints are restored upon EXIT from the Editor.

You can select from any of the instruction commands displayed at the top of the screen when the Sequencer is prompting you with a ":" symbol. Following is a detailed explanation of each instruction command:

^M or <RET> - MONITOR

MONITOR on/off (allows you to hear what you are editing). If the MONITOR is on and the track is not muted, any command that is restored is also outputted to its port.

^C - CHANGE

CHANGE currently displayed command entry. The Editor will redisplay the current command entry and position the cursor at the beginning of the command. At this point you can type in the full command entry as described below in INSERT or you can use the left and right arrow key to edit the line. Once <RET> is pressed, the Sequencer will erase from the <RET> to the end of the command entry and display the edited line, asking you if it is correct. If you type Y or <RET>, the Editor will restore and output the command entry, then display the next one. If you type N then the Editor will ask you to re-enter the command. You must type in the full command entry as described below in INSERT. Once this is done, the Editor will again display the edited line and ask for verification.

NOTE: The Editor will not assemble inverse video text. In

other words, if you want to change a command entry that is
muted, you must type in the full command as described in
INSERT.

WARNING: Do not change a command entry to a PRESSURE
command if your Chroma and/or Expander is not Interface
Software REV 3+. This will confuse the Editor and you will
LOSE YOUR SEQUENCE. You can change to pressure commands,
even if you do not have the pressure sensor option, as long
as the software in your Chroma is REV 3+, or you have a
Chroma Polaris.

^I - INSERT

INSERT command before currently displayed command entry.
Type in the full command entry as described below under
EDITOR COMMAND ENTRY SYNTAX. Alternately, you can type in
the shorthand version containing only the main command
opcode followed by the vital numbers, separated by a space.
The Editor will ask for verification as described above in
CHANGE then store and output the command to its port (if not
muted).

WARNING: Do not INSERT a PRESSURE command if your Chroma
and/or Expander is not Interface Software REV 3+. This will
confuse the Editor and you will LOSE YOUR SEQUENCE. You can
INSERT pressure commands, even if you do not have the
pressure sensor option, as long as the software in your
Chroma is REV 3+, or you have a Chroma Polaris.

^D - DELETE

DELETE currently displayed command entry. The Editor will
display the current command and ask for verification. If
you type Y or <RET> the Editor will not restore or output
this command entry and will display the next one in line.

^F - FIND

FIND command entry. The Editor will display the FIND:
prompt at which point you have the following options:

   (1) <RET> finds and displays the last command entry you
asked the Editor to find.

(2) Typing a command entry as described above in INSERT then <RET> finds the command and displays it. Any section of the command left out is "wild", in other words the Editor doesn't care. For example, FIND: ATTACK 1 -20 will find the next ATTACK in TRACK 1 that has a key number of -20, regardless of the VELOCITY or PRESSURE.

NOTE: If the command entry is not found, then END OF SEQUENCE will be displayed. Type a space bar (NEXT) or ^H (HOME) to get to the BEG OF SEQUENCE before trying again.

NOTE: The Editor can find time values or measure numbers that span a "distance" of up to 32768 relative to the next value. You must, therefore, make an intermediate "stop along the way" when finding values greater than 32768 higher than the next value. EXAMPLE: If the next time value is 2367 and you want to find TIME 44324, you should first find TIME 32000, then find TIME 44324.

NOTE: The find function only searches tracks that are in the EDIT TRACK LIST.

<SP> or <SPACE> - NEXT

Disassemble and display NEXT command entry. This instruction will cause the current command entry to be restored in the sequence. If the MONITOR is ON, the command will also be outputted to its port. The next command is then disassembled and displayed.

^X - EXIT

EXIT the Editor. The Editor restores the ENDPOINTS and exits back into page one of the main menu. The EDIT TRACK LIST is left intact.

^E - EDIT TRACK

Add a track to the EDIT TRACK LIST. Type the TRACK number followed by a <RET>. If that track does not exist, the Editor will tell you that the entry is invalid and ask for another track number. Typing <RET> without a track number aborts this mode.

^R - REMOVE

REMOVE a track from the EDIT TRACK LIST. Same as above, but removes a track from the list instead of adding it.

^S - STATUS

Display the current STATUS of the EDIT TRACK LIST. The EDIT
TRACK LIST is a list of all tracks that are currently being
edited. If a track is not being edited, the Editor will not
display or output commands in that track. Also, you cannot
INSERT or FIND command events in that track.

^H - HOME

HOME returns to the beginning of the sequence.

NOTE: If an error occurs, the current instruction is aborted and
an error message will be displayed. Following is a list of
Editor syntax errors:

12 - Unrecognized command in disassemble routine.
13 - Syntax error in entering command in the Editor.
14 - User attempts to change DEFINE command in Editor. This
     is currently illegal.
15 - User attempts to delete BEG OF SEQ (BOS) or END OF SEQ
     (EOS) command, insert before BOS/EOS command, or change
     BOS/EOS command. All of these operations are currently
     illegal.
16 - Track input out of range or not in EDIT TRACK LIST.

A sequence memory full error will display a message and
return the user to the main menu.

Editor Command Entry Syntax:

The following is a list of the command entries that are
allowed in the Editor and their correct syntax. An alternate
shorthand syntax is allowed in most cases which consists of the
command opcode (BOLD capitalized) followed by the parameters
(numbers only), separated by a space.
Operations on DEFINE commands are limited to display only.
Deleting or changing a BEG OF SEQUENCE or END OF SEQUENCE command
is not allowed. Also, inserting a command before BEG OF SEQUENCE
or END OF SEQUENCE commands is not allowed.

NOTE: Lever values are 0 at rest and pedal values are 0 at
'heel' or 255 at 'toe' position.

BEG OF SEQUENCE

END OF SEQUENCE

TIME XXXXX   where XXXXX is from 0 to 65535

MEASURE XXX   where XXX is from 1 to 65535

DEFINE TRACK#tt LEVER1=aaa LEVER2=bbb PEDAL1=ccc
     PEDAL2=ddd VOLUME=eee FOOTSWITCH=fff
                    where tt is from 1 to 16
                            aaa and bbb are from -128 to 127
                            ccc, ddd, and eee are from 0 to 255
                            fff is 0 if both footswitches up
                                128 if LATCH down, SUSTAIN up
                                 64 if LATCH up, SUSTAIN down
                                192 if both footswitches down

UNDEFINE TRACK#tt where tt is from 1 to 16

ATTACK TRACK#tt KEY#kkknn VELOCITY=vvv PRESSURE=ppp
                    where tt is from 1 to 16
                            kkk is from -64 to 63
                            nn is the musical note (this is
                                not required when inputting,
                                it is for your reference only)
                            vvv is from 0 to 31
                            ppp is from 0 to 63

RELEASE TRACK#tt KEY#kkknn VELOCITY
                    where tt is from 1 to 16
                            kkk is from -64 to 63
                            nn is the musical note
                            vvv is from 0 to 31

VOLUME TRACK#tt VALUE=vvv
                    where tt is from 1 to 16
                            vvv is from 0 to 255

LEVER1 TRACK#tt VALUE=vvv
                    where tt is from 1 to 16
                            vvv is from -128 to 127

LEVER2 TRACK#tt VALUE=vvv   same as above

PEDAL1 TRACK#tt VALUE=vvv
                    where tt is from 1 to 16
                            vvv is from 0 to 255

PEDAL2 TRACK#tt VALUE=vvv   same as above

SUSTAIN UP TRACK#tt   where tt is from 1 to 16

SUSTAIN DOWN TRACK#tt   same as above

```
LATCH UP TRACK#tt          same as above

LATCH DOWN TRACK#tt        same as above

PRESSURE TRACK#tt KEY#kkknn VALUE=pp
                    where tt is from 1 to 16
                          kkk is from -64 to 63
                          nn is musical note
                          pp is from 0 to 63

SET PARAMETER TRACK#tt PARAMETER#ppp VALUE=vvv
                    where tt is from 1 to 16
                          ppp is from 1 to 100
                          vvv  range depends on parameter
                               (see Chroma Performance
                               Manual)

SQUELCH TRACK#tt VALUE=vvv
                    where tt is from 1 to 16
                          vvv is from -64 to 63, or 128
                          (vvv is key, squelch all if 128)
```

Editing Tips:

When trying to find a note, it is advantageous to play the sequence and notice the LAST EVENT TIME: XXXXX message, then go into the Editor and find that time value. You must stop the playing of the sequence just prior to the note you are looking for.

The measure display during playback is also good for editing reference. Keep in mind, however, that if the Time Increment is a value other than 1X (see Chapter 9), the measure display is inaccurate.

When trying to add or subtract a time offset to every time command after a particular point in the sequence, use FIND:TIME then <RET>. After the first time value has been changed, use FIND: <RET> and the Editor will find the next time value and display it for changing.

DISK FUNCTIONS

This section describes the Program File management, Sequencer catalog and saving, loading and deleting sequences. It also describes the Polaris sequence management functions.

Program File Management:

Typing Q from the Main Menu displays a Program File Management Menu that allows you to transfer program data to and from the Chroma port and disk or from the Expander port and disk. Direct transfer of Program 0 between the Chroma and Expander port can be accomplished via the H-Chroma<>Expander main menu selection.

The Program File Management Menu displayed is as follows:

(instrument) ON CHROMA PORT:

        S - SAVE PROGRAMS ON DISK
        L - LOAD PROGRAMS FROM DISK

(instrument) ON EXPANDER PORT: (if Expander on line)

        ^S - SAVE PROGRAMS ON DISK
        ^L - LOAD PROGRAMS FROM DISK

    OTHER:

        D - DELETE PROGRAM GROUP FILE
        C - CATALOG PROGRAM GROUP FILES
    <ESC> - MAIN MENU

The files transferred are Program Groups. A Program Group is defined as an image of all the program data in the synthesizer (similar to a cassette tape dump). Chroma and Chroma Expander Program Groups consist of 50 program entries. In the Polaris, the number of programs in the group are variable. In the Polaris, if the program entry is empty, loading the program group from disk will not erase an existing program in that slot. It is only in this respect that the load function does not exactly simulate a cassette load. The actual structure of the program group file is detailed in APPENDIX B.

The delete menu selection D provides the user a second chance since valuable data can be lost. The disk catalog can easily be accessed when transferring from disk (L, ^L) and when deleting a file (D). When in Program File Management mode, the catalog displays only program group files.

Transfer of program groups between the Chroma and Expander ports can be performed indirectly by saving the Chroma port programs onto disk then loading them into the Expander port or vice versa.

The names of program groups that were used to record sequences can be stored in the sequence file for reference using the Comment program (User Utility Bank 1, number 0, see APPENDIX C). The names of program groups follow the syntax rules for all names outlined in APPENDIX P.

There are provisions for automatically loading program group files when a _sequence_ is loaded. If the phrase "CHROMA PORT USES filename," is found in the comment field when getting a sequence, the Sequencer will attempt to load the program group with that filename. Likewise, if the phrase "EXPANDER PORT USES filename," is found, the Sequencer will attempt to load that program group into the Expander port. The comma after the filename is required.

If the program group file is not found, or there is any other disk error, the Sequencer will sound a bell when loading the sequence. A file type mismatch error will occur if you try to specify a Polaris program group to be loaded into a port connected to a Chroma or Chroma Expander. Two bells mean that the loading of both the Chroma port and Expander port program group files experienced problems. If the phrases are not found, then no files are loaded and no bells are sounded. If the Chroma port program group file is successfully loaded, an inverse video C will be displayed to the left of the "(sequence name) LOADED..." message. If the Expander port program group file is loaded, an inverse video X is displayed.

Disk Catalog:

When the system is "up" and the main menu is being displayed, type F for DISK CATALOG and the catalog will appear. The catalog displays the list of program group (both Chroma and Polaris types), sequence, and Special Data (Polaris sequences and Multi-Instrument Fast Load) files that you have on the disk in Drive 2. If you are using a single drive system, the catalog lists those files on the Drive 1 diskette. If there are other files on the diskette (as will definitely be the case in a single drive system) the disk catalog simply does not display them.

At the top of the catalog on the left is the Volume number. This is useful for keeping track of several diskettes. The diskette can be assigned a volume number when you initialize it for sequence storage. Read your APPLE manuals and APPENDIX M to learn how to do this. The Sequencer pays no attention to volume numbers, it just relays that information for your use.

The next item at the top of the disk catalog is the number of free sectors left on the diskette. This indirectly tells you how many more sequences and program groups you can store on this disk. A blank 3.3 DOS diskette has available 494 sectors for sequence, program group, and Special Data storage. A single drive system has considerably less (approximately 190 sectors) since the Sequencer operating system must reside in Drive 1.

Each entry of the catalog also contains useful information. On the extreme left is the File Type. 'CHROMA PROGS' means that this entry is a Chroma or Chroma Expander program group, which is a group of 50 programs much like a "fast dump" section of a cassette for the Chroma. 'POLARIS PROGS' contain data for up to 132 Polaris programs. 'SEQUENCE' entries are obviously regular sequences generated by the Sequencer. 'SPECIAL DATA' files can be any one of several different types of data described in Appendix B. Currently, a Special Data file could be a Polaris sequence file, a Multi-Instrument Fast Load file, or a Multi-Instrument Setup file.

The next item in the catalog entry is the number of sectors that this file occupies on the diskette. This information, in addition to the free sector amount at the top of the catalog, can be used to determine how many more sequences or program groups you can store. For example, Chroma program groups always consist of 50 programs and always take 18 sectors. The next and last item in the entry is the file name which is used for loading, saving and deleting the files.

After the number of entries reaches the maximum allowed on the screen at any one time, the Sequencer asks you to type <SPACE> to continue. If you type an <ESC> at this point, you will abort the catalog. Once you get to the end of the catalog, typing any key to return you to the main menu.

Deleting a Sequence:

To delete a sequence from disk, select D from the main menu. The Sequencer will then ask if you want to see the disk catalog. Type Y if you do, any other key if you don't.   The catalog will display only sequences this time, since you do not care about program group files.

If the catalog takes more than one page, it will ask you to type a <SPACE> to continue or an <ESC> to abort at the current page. Once the catalog has been displayed, the Sequencer will ask for the name of the sequence to delete. You can abort and return to page one of the main menu at this time by typing <RET>. Otherwise, carefully type the name of the sequence then <RET>. At this point the Sequencer will warn you that you are about to delete data from the disk and ask for verification. Type Y to continue DELETE or any other key to abort. If all goes well (meaning that the file was found, etc.), the Sequencer will tell you that the sequence was deleted and will display page one of the main menu.

WARNING: Neither Apple DOS nor the Sequencer checks

file types when deleting files. You can, therefore,
inadvertently delete a Chroma or Polaris Program Group
file from the DELETE a sequence menu selection or
vice versa. It is important to never name a sequence
the same as a Program Group. The Sequencer will
create two separate files of the same name as long as
the files types are different. When deleting a file,
however, the Sequencer will delete the first file it
finds in the Catalog with that name, regardless of the
file type. Also, if you are operating a single drive
system, it is imperative that you never use the names
MAIN SETUP, HELLO, RECORD TRACK.1, CHROMA.BEGIN, or
any name ending in .HEX for sequences, program groups,
Polaris sequences, or Multi-Instrument setups.

Save a Sequence:

To save a sequence, type S. The Sequencer will display the
name of the sequence and ask if you want to rename it. If the
sequence has no name the Sequencer will disply the name as "".
If you change your mind about saving the sequence, type <ESC> at
this time and you will get back to the main menu. If you do not
want to change the name of the sequence, type any key except Y.
The sequence must be named before it can be saved.

Type Y if you do want to change the name before saving. The
Sequencer will then ask you to type in the new name. If you type
<RET> at this point, the sequence will be saved with the old name
(in other words, renaming is aborted). Legal sequence names are
those that follow the name syntax rules of APPENDIX P. You
should read the WARNING in the DELETING A SEQUENCE section above
regarding file names.

When the sequence is saved, various things are recorded
within the sequence file that reflect the system status, such as
the click track setting, instrument ID's revision numbers and the
timer source and increment, etc. All of this is detailed in
APPENDIX B.

NOTE: Entering SAVE SEQ mode, then typing <ESC> at renaming
is a good way to just find out the name of the current sequence.

Get a Sequence:

Loading a sequence from disk will erase any existing sequence, so you may want to save the old one as described previously in this chapter. To get a sequence, select G from the main menu. The Sequencer will then ask if you want to see the disk catalog. Type Y if you do, any other key if don't. The sequencer catalog will display only sequence files. After the catalog is displayed, type any key to continue. If an <ESC> is typed, the catalog will be stopped at the current 'page'. The Sequencer will then ask you to type in the name of the sequence followed by a <RET>. You can abort and return to the main menu at this point by typing <RET> instead of a file name. Otherwise, type in the name of the sequence followed by <RET>. If all goes well (meaning that the file was found, etc.), the Sequencer will tell you that the sequence was loaded and will return to the main menu.

There will be an inverse video space after the G - GET SEQUENCE menu selection and the MEMORY USAGE will display the percentage of total RAM occupied.

Loading a sequence will also set the Click Track, Timer Source, and Timer Increment that was set-up at the time the sequence was last saved.

It is also possible to automatically load program groups into the instruments when getting a sequence. All that is required is to put the phrase "CHROMA PORT USES filename," in the comment field before saving the sequence. When the sequence is loaded, the Sequencer will attempt to load the program group file specified. See the PROGRAM FILE MANAGEMENT section of this chapter for more details regarding this feature.

The Sequencer performs file type and revision level checking when loading a sequence. Sometimes a potential compatibility problem will be flagged and a message will be displayed, asking your direction. Descriptions of the possible messages are given below:

> The message "WARNING! ID MISMATCH - CONTINUE?" is displayed if the sequence was saved with a different instrument on the Chroma port than what is on the port at the time of loading. Normally this is not a problem, so you should respond by typing Y. If you do not want to continue, type N or <RET>. You may want to select this option (N) if the sequence contains a lot of Set Parameter commands whose parameter numbers and values are instrument dependent. To keep from having to answer this question each time you load the sequence, you must save the sequence after loading it.

The message "SOFTWARE REVISION MISMATCH -
CONTINUE?" is displayed if the software revision of
the instrument that was on the Chroma port when the
sequence was last saved is higher than the revision
of the instrument on the port at the time of
loading. Normally this is not a problem (the
Sequencer does not remember any commands that are
not implemented in all revisions of the Chroma), so
you should respond by typing Y. If you do not want
to continue, type N or <RET>. To keep from having
to answer this question each time you load the
sequence, you must save the sequence after loading
it.

The message "SEQUENCER SOFTWARE REVISION MISMATCH -
CONTINUE?" is displayed if the software revision of
the Sequencer at the time of the last save of the
sequence was higher than the software revision of
the Sequencer loading the sequence. Normally this
will never occur. But if it does (i.e. you go back
to an old Sequencer revision for whatever reason)
you should respond by typing Y. If you do not want
to continue, type N or <RET>. To keep from having
to answer this question each time you load the
sequence, you must save the sequence after loading
it.

The message "SEQUENCER SOFTWARE REVISION MISMATCH,
CANNOT LOAD SEQUENCE, PRESS ANY KEY TO CONTINUE..."
is displayed if you try to load a sequence that is
too many revision levels behind the current
Sequencer software revision. If this occurs, you
should try loading the sequences using a previous
revision of the Sequencer. Once they have been
loaded into the old revision Sequencer, save them
to upgrade one revision level. Then you can try
loading them with the current Sequencer revision.
The ability to load sequences two or three
revisions old uses memory that could be used for
other features, so it is not supported.

Polaris Sequence Management:

Selecting Y from the main menu invokes the Polaris sequence
management software. The Polaris features a built-in single-
track polyphonic sequencer with unique looping, chaining,
syncing, and tempo control features. The Polaris sequence
management software allows the user to save these sequences on
diskette, similar to the Program File Management software (see
the first section of this chapter).

It is also possible to send Polaris sequences back and forth
between the Polaris and a Model 1611 Sequencer track by means of

recording (see Chapter 5 for details).

When you select Y from the main menu, the following submenu
is displayed:

            S - SAVE SEQUENCES TO DISK
            L - LOAD SEQUENCES FROM DISK
            D - DELETE SEQUENCES FROM DISK
            C - CATALOG POLARIS SEQUENCES
        <ESC> - RETURN TO MAIN MENU

These functions work almost identically to the Program File
Management functions, except they send and recieve Polaris
sequence data instead of program group data.

Up to all 12 Polaris sequences are saved and loaded. An
empty sequence in a Polaris sequence file loaded from disk does
not erase a Polaris sequence that has data in it (unlike a pure
cassette load).

C catalogs Special Data file types, which also include
Multi-Instrument Fast Load and regular Multi-Instrument Setup
files. D deletes any file of the given name; no file type
checking is performed. A second chance to abort the delete is
given, however.

THE CLICK TRACK

The click track is really not a track at all. It is a hardware filtered pulse from the Interface PC board, which is controlled by the Sequencer software. This chapter describes how the click track is generated and used in the Sequencer, how to set it up and what restrictions apply to changing it once set up. This chapter also explains time signatures, MEASURE commands and how the Sequencer determines the loop time of a sequence.

How It Is Generated:

The Sequencer uses the BPM value input by you, among other things, in determining when to toggle a flip/flop on the Interface PC board. To emphasize the first beat of the measure, the Sequencer reduces the energy of subsequent beats by toggling the flip/flop twice (approximately 28 microseconds apart).

NOTE : The click output hardware is high impedance (appr. 10K). If you do not use an amplifier or mixer input that has an input impedance of at least 100K ohms, you may hear differences between each measure. You may even not be able to hear the emphasis on the first beat of the measure.

The Need For a Click Track:

Besides the obvious reason of helping you to keep the beat, the click track is used to determine measures in the sequence and to calculate the loop time. Loop time is calculated for you, as described below, as long as there is a click track that has been used for at least the first track record operation.

The click track may also be used in the recording studio to provide a stable audio reference for other instruments you may want to record. The Sequencer cannot "sync" off a pre-recorded version of its click track because the frequency is way too low. See Chapter 10 for syncing details.

Time Signature:

Time signatures in the click track can be anything from 1/1 to 15/15, although the musical value of some of these is questionable. The lower part of the signature (which type of note gets a beat) is not used by the Sequencer; but it is included for your information. The Sequencer will not syncopate any time signature, but the first beat of the measure can be emphasized.

Time signatures are required if you set up a click track.

They are used to tell the Sequencer when a measure boundary has ocurred and when to loop back to the beginning of the sequence when you are in loop mode.

How To Set It Up:

If a click track is to be used in a sequence, it MUST be set up prior to recording the first track. To set it up, select K from the main menu. After the overlay is loaded, the Sequencer responds by asking for the time signature. Anything from 1/1 to 15/15 is allowed. The Sequencer, however, doesn't use the lower portion (which type of note gets a beat). Enter the signature as you would write it on paper, i.e. 4/4 then <RET>. Typing <RET> instead of a time signature defaults to the current signature. When the Sequencer is turned on, the click track is set up at 60 BPM and 4/4 even though the indicator on page one of the main menu says NONE.

After you select a time signature, the Sequencer will display a small menu that looks something like this:

CURRENT SPEED IS 60 BPM

                        METRO MENU

            XXX - INPUT BPM (34-234) THEN <RET>

                 P - PLAY CLICK TRACK

                <ESC> - MAIN MENU

PLEASE SELECT...

The first selection (XXX) allows you to just type the BPM and press <RET>. If you type P to play the click track, the Sequencer will start to play the click as you have set it up so far and will display the following menu:

                    U - SPEED UP

                    D - SLOW DOWN

                <ESC> - METRO MENU

PLEASE SELECT...

Typing U will speed up the click track slightly. Use the <REPT> key at the same time as U and the click track will speed

up continuously. The same goes for D to slow the click track
down. When you are satisfied with the speed, type <ESC> to exit
back to the METRO MENU. You will now see the same menu as
before, except notice that the BPM value has been changed to the
current value. Type <ESC> again to return to the main menu.
Notice that the inverse video field after the menu selection K -
CLICK TRACK indicates that the click track is ON and that the
time signature and speed have been correctly set.

NOTE : The speed of the click track is effected by the
TIMER SOURCE, TIMER INCREMENT and the SPEED CHANGE pedal
position (if ON). The perceived speed of the click
track may not, therefore, be equal to the BPM shown.
The BPM indicators are correct only if the Sequencer is
driven by an INTERNAL clock with a TIME INCREMENT of 1X
and the SPEED CHANGE switch OFF.

NOTE : If the SPEED UP or SLOW DOWN selections are used
to set up the speed, the BPM display will round the BPM
to the nearest 1/2 unit. The BPM displayed in the main
menu is calculated using floating point math and is
rounded to within 1/10 unit. BPMs set under the K
selection are calculated using integer math, which is
slightly inaccurate. This explains some discrepancies
in BPM displays above 127 BPM.

Changing The Click Track:

When the Sequencer is powered up or the sequence is cleared,
the BPM is set at 60 and the time signature is set at 4/4. Other
than these default values being set up, the Sequencer acts just
as if there is no click track (NONE).
When the ^X - DELETE ALL MEASURES selection is made from the
main menu, the Sequencer erases all measure commands (described
below) as well as all traces of a click track. This sets up the
click track as if you had cleared the sequence (NONE).
There is a difference between OFF and NONE. NONE means that
there was never a click track and the Sequencer can not store
measure commands and may not loop in perfect time. This is not
true if the click track is merely OFF, even if you extend the
endpoints of sequences during record operations.
Once the first track of a sequence has been recorded, you
can only turn it OFF or ON and change the speed via the BPM
value.
To turn a click track OFF once a track has been recorded,
just select K from the main menu. When the Sequencer asks if you
want a click track, press N.

To change the tempo once a track has been recorded, just
select K from the main menu. When the Sequencer asks if you want
a click track, press Y. The Sequencer will then ask if you want
to change the tempo. If you do, type Y, then the Sequencer will
display the current BPM setting and ask you to type in a new BPM

value. If no change is desired, type <RET>. Otherwise, type in
a number between 34 and 234 inclusive, then <RET>.

When a sequence is loaded from disk, the click track is set
exactly the way it was when the sequence was last saved.

External Clock Considerations:

You should not have a click track ON when using an EXT CLK
timer source. If an EXT CLK is the timer source, measure
commands are stored automatically according to the CLKS/BEAT
parameter (see RECONFIGURE, Chapter 9) and the click track time
signature.

When K is selected from the main menu and an EXT CLK is the
timer source, the Sequencer will ask you for the time signature
and the CLKS/BEAT specification of your external clock source.
The selections are 24, 48, and 96 clocks per beat. Other values
are available from RECONFIGURE (see Chapter 9), but only these
three values are compatible with the Quantizer (see Chapter 6).

Nothing can be changed if there is already a track recorded,
so the K selection just returns to the main menu if there is a
sequence in RAM and the timer source is EXT CLK.

Measure Commands:

Measure commands are stored by the Sequencer right at the
first beat of the measure, starting with MEASURE 1. These
commands are used as ENDPOINT references and as markers in the
Editor.

MEASURE commands are stored while recording subsequent
tracks only if you extend the length of the sequence. This will
occur whether the click track is ON or OFF, but will never occur
if the click track is NONE (unless the timer source is EXT CLK).

If you play the downbeat slightly before the first beat of
the measure, that note will logically fall into the previous
measure. When this happens and you reference the measure for an
ENDPOINT, you may not hear the down beat. If this occurs on the
first note of a sequence, it will also effect the loop time, as
explained below. This problem can be remedied by moving the
ATTACK command right after the MEASURE command via the Editor or
by quantizing the two measures in question (see Chapter 6).

The measure number is displayed in the lower left-hand corner of the CRT screen during record and play modes. You will notice that playback with an internal clock begins on MEASURE 0, while an externally clocked sequence begins on MEASURE 1. The measure number displayed is valid (coincident with MEASURE commands stored in the sequence) only if the TIME INCREMENT is 1X (see Chapter 9). Also, if pickup notes of an internally clocked sequence are quantized, a measure is inserted at the beginning. If this occurs, all subsequent measures are incremented.

Loop Time:

The Sequencer will correctly determine the loop time if the first track of a sequence was recorded with a click track and you follow a few simple rules when beginning and terminating all track record operations. If these rules are not followed and/or you reference ENDPOINTS other than the actual beginning and ending of the sequence, the Sequencer may have to add a measure's worth of time to the loop. The end result will be a full measure rest between loops. Looping with a slow EXTERNAL clock requires a little more effort as described in Chapter 10.

When you record the first track, the Sequencer takes note of the time the first event occurs relative to the click pulse time and the beat of the measure. This information is saved with the sequence and is not updated unless you change it by recording a note on a subsequent track before the first event of the first track. By the way, the only way you can do this is by recording subsequent tracks with the click track ON, since it is only under this condition that the Sequencer starts the recording mode one measure before the start of the sequence.

When the last event is played in the sequence, the Sequencer loops back around and presets the timer to a value that will cause the first note to be played in time. The last event in this case is not a RELEASE but when you press the space bar or footswitch to terminate the record operation.

The main rule regarding loop time is that you must allow enough time for the Sequencer to do its job. The last event in a sequence must occur such that there is sufficient time left in the measure to play the first note on time. Sometimes this requires the use of the Editor to delay the first event time or pull back the last event time.

Most of the time, it is easy to follow these simple rules while you are recording. If you need to touch it up, however, MEASURE commands stored in the sequence are a good indication of where these events must occur in time. In general, if you want to start the sequence on the down beat, the first event must occur slightly after the down beat and the last event must occur slightly before the down beat of the next measure. Give the Sequencer a few TIME INCREMENTS between each end to accomplish its task.

8 - 6

Again, if you do not follow these rules, the worst that can happen is that the loop time will be increased by a measure's worth of rest.

If a click track is not used, the only thing determining loop time is the first event and when you press the footswitch or space bar at the end of the record operation. There will be a slight processing delay for which you will have to learn to compensate. This delay will be constant for a given length of sequence. The Sequencer will take care of this for you only if you use a click track.

When using an EXTERNAL clock, loop time requires special considerations that are explained in Chapter 10.

RECONFIGURE

The X - RECONFIGURE selection from the main menu allows you to change certain operating parameters of the Sequencer. These paramenters involve the timer, SYNC input, FOOTSWITCH input, click track, Expander port, disk drives, the Interface PC board slot, and RAM expansion. RECONFIGURE, therefore, is very useful when installing your Interface Kit and when attempting to interface the system to drum machines and other sequencers.

When the selection is made, the following menu will appear:

RECONFIGURE:

      C - CHANGE THIS SET-UP

      S - SAVE THIS SET-UP

      L - LOAD SET-UP

      V - VIEW CURRENT STATUS

    <ESC> - MAIN MENU

      CAUTION : THESE SELECTIONS SHOULD BE
      MADE WITH A KNOWLEDGE OF THE SEQUENCER
      SYSTEM - CONSULT YOUR OWNERS MANUAL!

PLEASE SELECT...

This chapter will explain each of these RECONFIGURE selections in detail. When you want to exit to page one of the main menu, just type <ESC> when this menu appears.

NOTE: Changes in the interface PC board slot and RAM expansion will be implemented only if you make the changes, save the setup under `MAIN SETUP', then reboot the Sequencer. If you return to the main menu after the change, but before the save, the change will be aborted.

View Current Status:

    This selection enables you to view the way the parameters
are currently setup. It also allows you to learn what the
various software revisions there are in the system and the
connection status of each port.
    A detailed explanation of each entry in the status display
follows:

                        CHECK SYNC: Y

This line tells you if the Sequencer will wait for positive
going pulses on the SYNC input before starting to play. If
CHECK SYNC? is Y, then the Sequencer will display
"PLAYING...WAITING FOR SYNC..." when you select PLAY or
PLAY ALONG from the main menu. When the required number of
pulses are received, the Sequencer will start playing. The
WAITING FOR SYNC... message will not be cleared. The
Sequencer will not wait for SYNC pulses on subsequent
loops.

                    WAIT FOR HOW MANY: 0

This is displayed only if CHECK SYNC? is Y. The number
represents the number of pulses -1 that must occur before
the Sequencer will start playing. If you are using a
footswitch in the SYNC input, it must be TTL compatible.
The number of wait pulses should be 0 in this case because
of probable switch bounce. The range allowed is 0 to 15.
The hardware timing restrictions are specified in APPENDIX
O.

                    CHECK FOOTSWITCH: Y

The footswitch is used to tell the Sequencer when to start
recording and when to stop playing or recording. The
debounce software requires that the Sequencer know if there
is a footswitch connected in the FOOTSWITCH input. If you
plan to use the Sequencer without the footswitch connected,
you must set this to N or the Sequencer will not PLAY a
sequence.

                  EMPHASIS ON FIRST BEAT: Y

If this is Y, then the click track will emphasize the first
beat of the measure.

TIMER SOURCE: INT

The timing information can currently come from 4 sources:

SYMBOL	SOURCE	ACCESS
INT	Internal	I
EXT	External	E or X
SS1	Single Step1	S
SS2	Single Step2	^S

Single Step1 currently is not used (doesn't work). Single Step2 is designed to increment the timer every low to high transition on the SYNC input. It can sense TTL pulses of greater than 3 milliseconds apart or a footswitch in the SYNC input. If a footswitch is used, the timer will increment when the footswitch is depressed (if the footswitch is a normally closed one).

CLK/BEAT: 24

This is displayed only if the Timer Source is EXT. The value can have a range of 0-255, however, you should limit it to 24, 48, or 96 to be compatible with the Quantizer (see Chapter 6).

TIME INCREMENT: 1X

The TIME INCREMENT is the amount of increment in the time value for every timer source pulse. The options are 8X, 4X, 2X, 1X, 1/2X, 1/4X, 1/8X and 1/16X. This parameter allows a quick method of doubling or halfing the speed of the sequence while keeping the click track intact. It is very useful for recording at 1/2, 1/4 speed, etc. It is also useful when converting a sequence to run on a TIMER SOURCE that is different than the one on which it was recorded. If the Time Increment is set to a value other than 1X, the measure display during recording and playback will be inaccurate.

SEQUENCER REVISION: 6

This is the software revision of the Sequencer program you are running.

THIS SEQ SEQUENCER REV: 6

This is the software revision of the Sequencer program that was used the last time this sequence was saved. Essentially, it is the software revision of the sequence. The file structure of sequences are designed to be transportable. In other words, you can send a song to a friend! This sort of information is useful when there are several revisions of Sequencers in the field.

THIS SEQ INSTRUMENT: Polaris/Expander

This is the instrument(s) that was used the last time this sequence was saved. The first instrument tells what was connected to the Chroma port and the second one tells what was connected to the Expander port.

THIS SEQ INSTRUMENT REV: 7/3

This is the interface software revision of the instrument(s) that was used the last time this sequence was saved. "REV 12" Chroma software has an interface software revision of 2. "REV 14" Chroma software has an interface software revision of 3. A Polaris software revision number coincides with its interface software revision number. See APPENDIX K for a complete discussion of instrument and Sequencer software revisions.

CHROMA PORT STATUS: Polaris, REV: 7

This is the instrument and its interface software revision that is currently connected to the Chroma port.

EXPANDER PORT STATUS: Expander, REV: 3

This is the instrument and its interface software revision that is currently connected to the Expander port.

AUTO REROUTE: Y

The AUTO REROUTE parameter, when 'Y', allows the Sequencer to automatically send a track to the Expander port whenever you attempt to send more than 8 tracks at once to the Chroma port.

DISK SLOT: 6

This is the current Disk Controller slot number. The
Sequencer will support only one disk controller. It
determines the slot when you power up and provides this
information for your reference.

NUMBER OF DRIVES: 2

This is the number of disk drives that are connected to the
system. If it is 1, then the Sequencer will direct all
disk accesses to Drive 1. If it is 2, then the Sequencer
will access Drive 2 for catalog, sequences and program
groups and Drive 1 for RECONFIGURE setups.

INTERFACE SLOT: 5

This is the Interface PC board Slot number.

RAM STATUS: 448 sectors, slot 2

This is the expanded RAM status. It indicates the type of
RAM and the RAM card slot. If expanded RAM is not
installed, the RAM STATUS is "non expanded".

Changing This Setup:

        This selection allows you to change several of the
parameters described in VIEW CURRENT STATUS above. When the
colon appears, you may select any of the options that apply to
that particular parameter. In this manual, the options are
listed to the right of the colon. <DEF> means default, leave it
has it is, and is selected by typing <RET>.

CHANGE SET-UP...

CHECK SYNC: : Y, N, <DEF>

WAIT FOR HOW MANY: : 0 through 15, <DEF>

CHECK FOOTSWITCH: : Y, N, <DEF>

EMPHASIS ON FIRST BEAT: : Y, N, <DEF>

TIMER SOURCE: : INT, EXT, SS1, SS2, <DEF>

CLK/BEAT: : 0 through 255, <DEF>

TIME INCREMENT: : 8X,4X,2X,1X,1/2X,1/4X,1/8X,1/16X,<DEF>

AUTO REROUTE: : Y, N, <DEF>

NUMBER OF DRIVES: : 1, 2, <DEF>

INTERFACE SLOT: : 2 through 7, <DEF>

EXPANDED RAM: : Y, N, <DEF>

RAM SLOT: : 0 through 7, <DEF>

NOTES : WAIT FOR HOW MANY: is displayed only if checking SYNC.

        CLK/BEAT: is displayed only if the Timer Source is EXT.
                   Although the range is 0-255, the value should
                   be limited to 24, 48, or 96 if the Quantizer
                   (see Chapter 6) is to be used on this sequence
                   at any time.

        RAM SLOT: is displayed only if RAM is expanded (RAM
                    STATUS is not NON EXPANDED).

        In TIME INCREMENT, you do not have to type the X.

Saving This Setup:

        This allows you to save the changed setups for easy
recall later. If you save it under the name of 'MAIN SETUP',
then that setup will be loaded upon power up. The names must
follow the name syntax as outlined in APPENDIX P. You should
also read the WARNING regarding names in DELETING files in
Chapter 7. The Sequencer saves the setup as a binary file on
Drive 1, regardless of the number of drives in the system. Since
there is no RECONFIGURE setup catalog, you should name the setups
such that they will be easily recognized when you catalog drive 1
from DOS.

Loading Setups:

        This allows you to load presaved setups immediately.
There is, unfortunately, no menu selection that allows you to
catalog these setups. You can find setups by following these
steps:

        1) Save any existing sequences onto disk (see
           Chapter 7).

        2) Select <ESC> to FP from the main menu.

        3) Type CATALOG,D1 and <RET>. All files on
           Drive 1 will be displayed. Notice the setup
           file you want to reference.

4) Reboot the computer.

5) Select X from the main menu to return to
   RECONFIGURE.

6) Load the setup.

If you load MAIN SETUP, the power up setup will be loaded.

DELETING SETUPS:

The Sequencer currently does not support the deletion of
RECONFIGURE setups. If you must delete them (to get more disk
space, etc.) you can do the following:

1) Save any sequences in RAM onto the diskette (see
   Chapter 7).

2) Select <ESC> to FP from the main menu.

3) Type CATALOG,D1 and <RET> then, when you have
   found the setup file, DELETE it.

4) Reboot the computer.

EXTERNAL SYNCING

The Sequencer can be controlled by external timing information in many different ways. The most important Sequencer operation parameters when trying to interface it to another system are the TIMER SOURCE, CLKS PER BEAT, and TIME INCREMENT. The EXTCLK input is the most often used; however, the SYNC input can also help to solve external syncing problems. The details of these parameters, including checking the SYNC input, are presented in Chapter 9, RECONFIGURE and will not be duplicated here. In this Chapter, it will be assumed that you understand these parameters.

General Requirements:

The interface hardware and software can sync as a slave to an external device. The external device (drum machine, sequencer, etc.) is a master that sends a clock signal to the Sequencer. The Sequencer then records and plays back according to the speed of the clock signal. The signal specification is detailed in Appendix O, however, an additional requirement is that the signal must be gated. In other words, the clock signal must not change until the external device begins to play and must stop changing when the device stops. Notice that the waveform must have a duty cycle between 25% and 75%.

The interface hardware clocks an external signal on the falling edge. Under most conditions this presents no problems when interfacing to positive edge devices that output normal clock frequencies. If the small delay (25 milliseconds maximum with a 24 pulse per beat clock at 50 BPM) is objectionable, you will have to invert the clock signal with hardware.

The Sequencer does not measure the EXTERNAL clock input, but uses the falling edge of the input as a source of time interrupt. This means that a relatively high frequency is required for enough resolution in real time multi-track recording, which is what the Sequencer does best. In general, there is a very slight resolution problem due to the low clock frequencies of most drum machines on the market. They are different between units, but generally the frequency is 24 or 48 pulses per beat. The speed of the drum sequence can generally be varied from 40 to 250 BPM so the clock frequency is between 16 and 200 Hz. This is enough resolution for sequences that contain only a few tracks; beyond that, you will begin to notice timing errors. Some drum machines output clocks up to 400 Hz, which should present no problems. In no case is the error cumulative.

Recording With Drum Machines:

To record a sequence, the following steps should be followed:

(1)   Connect a cable between the clock output of the external device to the EXTCLK input of the interface connector box.

(2)   Use RECONFIGURE to select an external clock and sets its CLK/BEAT (see Chapter 9).

(3)   Select a pattern on the drum machine with which to record. This will be your "click track." Make sure that the Sequencer's click track says EXT. The drum machine pattern can be edited later and still be in sync.

(4)   With the drum machine not playing, go through the normal recording selections. Go all the way, until the inverse video message appears (RECORDING...).

(5)   Start the drum machine playing. Play the Chroma along with the drum pattern whenever you want the music to start. Keep in mind that during EXT CLK mode the time delay between the first drum beat and when you first play a note will be remembered and played back exactly.

(6)   Stop the recording as normal, then stop the drum machine.

(7)   Save the sequence, if desired, then repeat steps 4 through 6 until you are through with the sequence.

Playing With Drum Machines:

To play a sequence the following steps should be followed:

(1)   With the drum machine not playing, press P for PLAY or W for PLAY ALONG.

(2)   When the Sequencer displays "PLAYING...", turn on the drum machine.

(3)   Play to the end of the sequence or press the space bar or footswitch to stop.

(4)   Stop the drum machine.

When recording or playing back, you must make sure that the

speed change function is OFF (see Chapter 6).

Also, some drum machines have start/stop switches that bounce if not depressed deliberately. If this happens, the two devices will get out of sync because the drum machine will output a few pulses, then stop and start over.

With some drum machines, it is possible to create a song that stops at the end rather than looping forever. If this is the case, you should make the drum machine song end at the same time as the sequence. Full use of rests and special rhythm patterns at the beginning and end of the drum song will create a professional sounding result.

Once the sequence is saved, the timer source (EXTERNAL) is saved and reloaded along with the other data. In other words, it is not neccessary to change the timer source in RECONFIGURE when loading an externally synced sequence from disk.

It is not possible to record a sequence using the internal clock, then change to an external clock and have them be in sync. It is possible, however, to change the other way (external to internal) by changing the TIMINC and using the speed changing functions to increase the number of clock pulses required between events (the internal clock frequency is 1000 Hz.).

Looping works exactly like looping without a click track, meaning that it is very difficult. The time delay (count off) introduced when recording the first track is included in the loop. You must be careful when you stop the recording of the first track or any extended track, since this is also included in the loop time calculation. Modifying the timing with the editor (see Chapters 6 and 8) is possible and probably necessary.

Compatible drum machines currently consist of the LM1 Drum Machine, the LinnDrum (1), the Drumulator (2), and most gated clock drum machines that output 0-5 volts at rates of 24 clocks per beat or higher. Connection between the LM1 and the Sequencer is between the Trigger output (set at maximum frequency) and the EXTCLK input of the Sequencer. Connection to the LinnDrum is between the SYNC OUT and the EXTCLK input of the Sequencer. Connection for the Drumulator is between the CLK/CASS OUT and the EXTCLK input of the Sequencer.

It is also possible to clock the Sequencer with the Polaris' SYNC OUT signal. This allows you to syncronize Polaris sequences with Sequencer tracks.

Some drum machines are not directly compatible. Small modifications to the interface hardware may allow you to sync them to the Sequencer software. These modifications are described below. However, you will void your warranty if they are performed on the actual PC board.

The Oberheim DMX (3) clock output has a constant pulse width of 104 microseconds. This is less than the minimum required duty cycle of 25%. It is possible to change R48 on the interface PC card to allow this small pulse width. This method is not recommended since it may work differently for various clock frequencies and will void your warranty.

A better method is to route the clock signal to a toggle flip/flop (74LS74). This will provide a square wave at one-half the original frequency, which can be directly sent to the connector box EXTCLK input. The frequency division presents no

problems, since the DMX is very fast to begin with. The required
IC should be mounted on an Apple prototype board and inserted
into your computer. The following circuit should work.

ALL RESISTORS ARE
1/4W, 5%
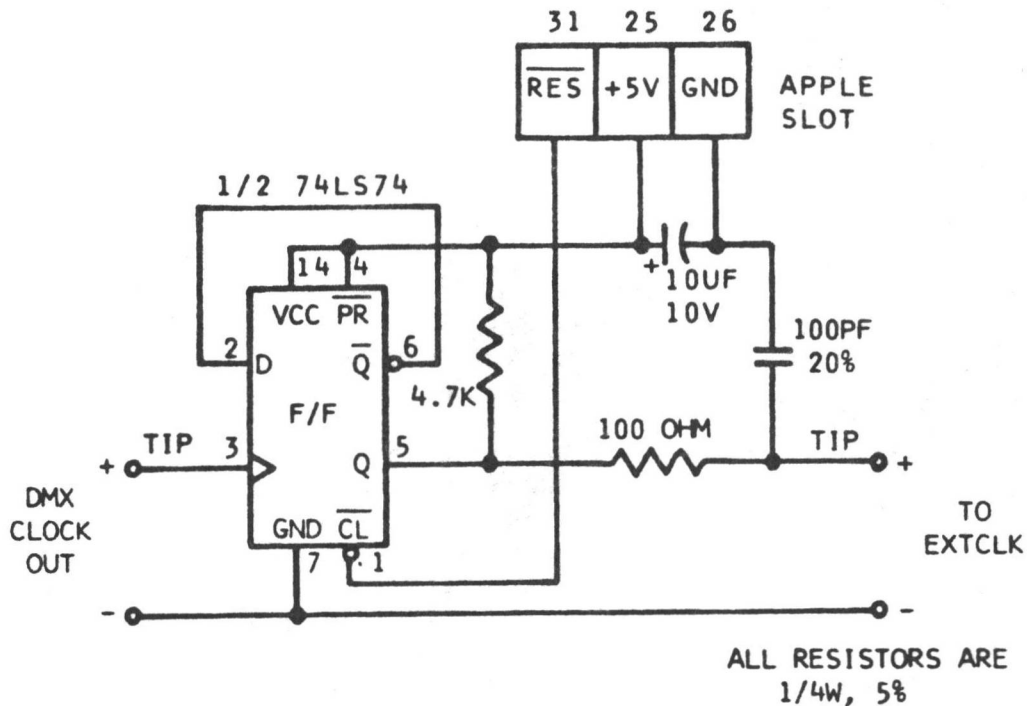
The Roland TR808 and TR606 (4) present a more complex
problem, but an easier solution. The clock signal is not gated.
Instead, the clock is free running and a start/stop signal is
provided. It is possible to gate the free running clock with the
start/stop signal, providing a compatible clock signal. The
following circuit should work:

ALL RESISTORS ARE
1/4W, 5%
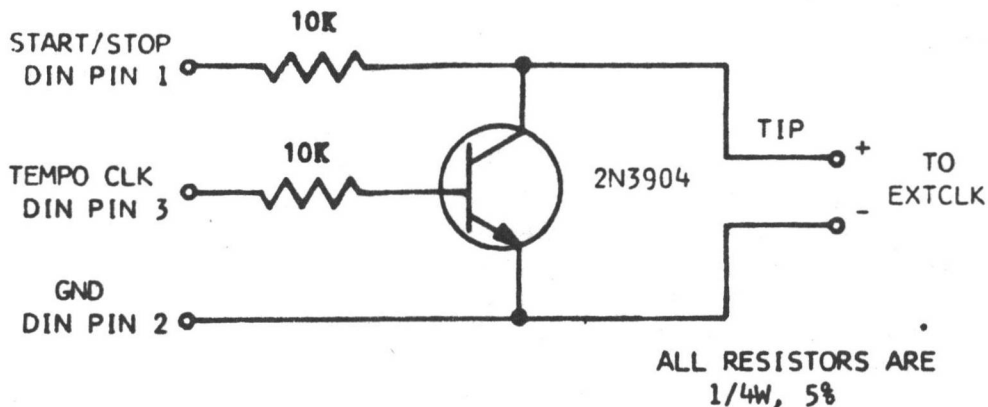
The sync switch on the Roland TR606 and TR808 should be set
to OUT since it will be the master. Pins 4 and 5 of the DIN
connector are not used. This circuit could be mounted inside a
custom-built cable. The slow speed of the TR606 and TR808 and
the clock inversion of this circuit may cause undesirable delays.

Additional External Timing Options:

Single Step:

Lower frequencies (100 Hz to DC) can generally be accomodated using a Single Step2 (SS2) TIMER SOURCE. The SS2 timer source mode accepts a TTL compatible signal connected to the SYNC input. This input can also be used with a footswitch to manually increment the timer during record or playback mode.

The general procedure would be to record using a slow clock or footswitch in SS2 mode, then play back using the EXTERNAL clock mode. This can be cumbersome, but it does work. In one experiment, we have used this method and clocked the Sequencer to play with an envelope follower driven by the bass drum output of a drum machine. In the studio, the control voltage output of a VCA (such as that found in a KEPEX) can be used to clock the Sequencer. Generally, you want a short attack and release time, maximum ratio and adjust the threshold for whatever drum you are using for the clocking.

Using The SYNC Input:

If you record with an ungated external or SS2 Timer Source, you may need to tell the Sequencer when to start playing a sequence.

The Sequencer normally sets its internal timer to the first time value in the sequence before playing. It first plays the first event, then waits for timer increments. When it is time to play the next event it will do so.

After a track is recorded, a User Utility Bank 1 Number 2 (TIME0) is automatically invoked. This utility inserts a TIME 0 command at the beginning of a sequence if the sequence was recorded with an external or SS2 Timer Source. On playback, the Sequencer will wait the same number of clock pulses that occurred during recording.

If you do not want this, you must effectively delete the TIME 0 command and change RECONFIGURE to wait for a transition on the SYNC input.

You cannot, however, just delete the TIME 0 command. You must, instead, change the time value of the command to the same as the next TIME command. This is very easy to do in the Editor (see Chapter 6).

The SYNC signal can be obtained from a variety of sources, including a trigger output of a drum machine. The signal, however, must be TTL compatible, as detailed in APPENDIX O.

When using the sync method, you must consider what happens in loop mode. When looping back, the sequencer does not check the SYNC input. Instead, it will loop back immediately (assuming you don't have a click track). The pressing of the footswitch or space bar at the end of recording is critical in this application. The loop processing time may also cause cumulative error problems if the external clock speed is relatively high.

Syncing To Tape:
The Sequencer does not provide a sync-to-tape output signal. It relies on the use of a drum machine for this capability.

The general procedure is to lay down a sync track from the drum machine onto audio tape, then use the drum machine and the Sequencer (without the tape machine) to record the track(s) of a sequence. Once the sequence is finished, record (to tape) the drum machine and Sequencer audio while the sync track on tape is controlling the speed of the drum machine, which is controlling the speed of the Sequencer.

Some drum machines (such as the Drumulator (2)) do not have separate external clock and sync-to-tape outputs. If this is the case, try using a Y-adapter to split the signal from the sync track of the tape to both the drum machine and Sequencer external clock inputs.

Some users have had luck with recording sync tracks at -7db. Of course, experimentation with your particular setup will produce the best results.

The Arpeggiator:

Several people have asked if the arpeggiator in the Chroma can be synced to a drum machine. The answer is no. The Chroma does not have an accurate hardware timer with which it references the arpeggiation speed. It establishes the speed by a software loop, which shortens or lengthens, depending on how busy it is. Although it is easy to record a Chroma arpeggio with the Sequencer, the exact number of notes heard will be different from when it was played. It will again be different after recording another track, because the Chroma will see an increase in the amount of data transmitted across the interface. It is, therefore, useful to have the capability of syncing through an external computer.

The J - ARPEGGIATOR selection from the main menu makes it possible to sync arpeggios and chords to an external device, such as a drum machine. The program receives key depression (attack) commands from the Chroma synthesizer and builds its own arpeggios, so there is no need to use the arpeggiation algorithms in the Chroma. The program tells the Chroma to attack and then release one or several notes whenever the EXT CLK input jack receives a trigger pulse from the external device.

In addition, the left footswitch (footswitch 2, latch) is redefined to act as a "hold" switch. When the switch is depressed once, any notes that are currently held will continue to be triggered until the switch is depressed a second time. Notes can be added while the hold switch is on, including notes that are already sounding, making an arpeggio sound the same note more than once in the pattern. Any notes added after the eighth note (fourth note in a "linked" program) will be written over the oldest note.

There are provisions for sequentially adding octave transposed arpeggios to the main arpeggio and for controlling the length of the notes, the linked program and the Expander port. These features, as well as the arpeggiation modes, are detailed below.

The menu presented to the user allows him to easily select between five (5) arpeggiation modes.

ALL NOTES. Upon receipt of a trigger pulse, all notes that are held will be attacked simultaneously, then released (according to the note length parameter described below). As in all modes, no notes will be heard until triggered externally. This mode works well when triggered with an interesting rhythm from a drum machine.

ARPEGGIATE UP AND DOWN. The notes held will be played one at a time in an arpeggio moving up and down. The pattern will start ascending and will be repeated until the keys are released.

ARPEGGIATE BY LEVER 2. Performance lever 2 on the Chroma determines the direction of the arpeggio. Pushing the lever forward once will create an ascending pattern while pulling back once will create a descending pattern. An ascending pattern is automatically set when this mode is selected. The user can change directions in mid-pattern by moving the lever in the desired direction. A nice effect is to use a short, plucked type of sound, add three octaves, turn the drum machine up to full speed triggering sixteenth notes, hold down the sustain footswitch, then play single notes or simple chords to get a quickly strummed harp sound.

RANDOM. The notes held are triggered one at a time in a random pattern. The octave of the note will also be selected at random (according the octave add range described below).

SEQUENCER. The notes will be played according to the order in which they were depressed, creating an eight note sequencer.

Also selected from the menu are the following special feature

controls:

NOTE WIDTH. This parameter describes the duration of the
triggered note.   Ten values are available and are
continuously updated and displayed in the menu as 0
through 9, zero being the shortest. Selecting L from the
menu lengthens the note duration, while selecting S
shortens it.   These are single key selections, not
requiring a computer keyboard carriage return. When using
the longer note values there is a maximum speed that an
arpeggio can play before the end of one note reaches the
beginning of the next. When this point is reached, the
arpeggio appears to slow down because the program is
ignoring any triggers that occur while the note is being
played.

OCTAVE ADDITION. This feature allows the user to
sequentially add octave transposed versions of the
arpeggio. Up to three (3) octaves can be added to the
length of the arpeggio in all arpeggiation modes
(including ALL NOTES). The currently selected octave
addition option is continuously updated and displayed in
the menu as NONE, 1 OCT, 2 OCT or 3 OCT. Selecting A
switches to the next available option. Again, this is a
single key control. When in one of the added modes, the
pattern or chord is played before being repeated an octave
higher (lower if descending). If your pattern spans more
than an octave, the arpeggio will back up when changing
octaves. This can be used to create some interesting
patterns.

LINK CONTROL. This parameter has two (2) values,
indicating that the linked instrument can be either
TRIGGERED along with the main instrument or allowed to
play as NORMAL. The status is continuously updated and
displayed in the menu and is toggled between the two
states with the single key N. The NORMAL mode is used for
creating a normal sound on top of a synced sound, maybe
with a keyboard split or with a link unison setup. When
TRIGGERED is selected, an additional arpeggiator is
invoked for the linked keys.   The main and link
arpeggiators are triggered simultaneously but each is
controlled by its respective keyboard section. The two
arpeggiators are best appreciated with a split keyboard.
Both arpeggiators run in the same mode and they are both
eight (8) notes long.

EXPANDER (X). This toggle selection enables or disables the Expander port. The selection is displayed only if an instrument is on line at the Expander port. It is useful to disable the Expander port if the instrument connected to it is playing a sequence of its own (as could be the case if a Polaris is connected to the Expander port).

Support is provided for the Expander port by automatically transferring performance information from the Chroma port whenever events occur while under control of the main menu of the Arpeggiator (while idling). Information originating from the Expander is ignored.

In addition, while under the arpeggiation modes, all Main instrument notes normally sent back to the Chroma port are also sent to the Expander port. Link instrument notes are not sent to the Expander port while arpeggiating. Volume balance between main and link is not transferred to the Expander if the Chroma is revision 12 (interface revision 2) or below. If this is the case, you must set your balance before entering an arpeggiation mode.

Parameter and panel changes are not transferred in either direction. Voice changes on the Chroma, therefore, will not change voices on the Expander.

The Arpeggiator undefines instrument 0, which causes a Polaris control panel to go blank (similar to turning its Main local control switch off). This creates no problems but it may come as a surprise.

The sustain footswitch (footswitch one) creates a nice effect by blurring the arpeggio. This sounds nice with a slow sweep or when used in conjunction with one of the Chroma's internal arpeggiation algorithms.

You can change programs on the Chroma while an arpeggio is playing but you must start with a link unison program if you plan to switch between linked and unlinked programs.

You may notice a slight delay in the arpeggio when it is being triggered from some drum machines. The EXTCLK input triggers on the falling edge of a pulse, so if your machine puts out a wide, positive pulse the note will be as late as the pulse is wide. The delay isn't too noticable when using the LinnDrum (1) or Drumulator (2), but is noticeable on the Roland TR808 (4). The solution would be to invert the signal with hardware.

The Arpeggiator will attack a note on each trigger pulse. The normal external clock output of most drum machines is too fast (24 pulses per beat, etc.). What is required in this type of syncing is a 'trigger' output. The Linndrum(1), for example, can be programmed to output a trigger every time the cowbell is to be played. The Drumulator(2) can be programmed to output a trigger pulse every 1/8 or 1/16 note at the metronome output. See your drum machine manual for details.

In addition, the Arpeggiator will trigger off of most drum audio! Try connecting the snare or bass drum audio output of the drum machine to the EXT CLK input of the Sequencer.

(1) LinnDrum and LM-1 Drum Computer are registered trademarks of Linn Electronics, Inc.

(2) Drumulator is a registered trademark of E-mu Systems, Inc.

(3) DMX is a registered trademark of Oberheim Electronics, Inc.

(4) TR-606 Drumatix and TR-808 Rhythm Composer are registered trademarks of Roland Corporation.

Notification that certain drum or rhythm machines are compatible with Fender Musical Instruments Corporation's products should not be construed in any way to represent any endorsement, official or otherwise, by the respective rhythm machine manufacturers or by Fender Musical Instruments Corporation.

MISCELLANEOUS MENU SELECTIONS

This chapter describes some miscellaneous main menu selections
that do not logically fit into the other chapters. They include
real-time performance aids, test programs, and other
miscellaneous functions.

CHROMA<>EXPANDER Communication:

The H - CHROMA<>EXPANDER selection allows the direct
transfer of data from the Chroma port to the Expander port and
vice versa, simulating the connection of a cable between the two
instruments. The program can transpose the note and pressure
information as well as copy the master tune value from the Chroma
to the Expander port. This gives at least a good starting point
on getting the two instruments in tune.

When H is selected, the following menu appears:

THE (instrument) ON THE CHROMA PORT AND THE
(instrument) ON THE EXPANDER PORT ARE NOW
COMMUNICATING PERFORMANCE INFORMATION.


```
            T - TRANSPOSE  0
            U - UP 1 OCT
            D - DOWN 1 OCT
            0 - CLEAR TRANSPOSE
            1 - 0
            2 - 0
            3 - 0
            P - PROGRAM MODE
            C - COPY TUNING

        <ESC> - EXIT TO MAIN MENU
```


The zeroes are in inverse video and the computer is waiting
for your selection. In the meantime, it is transferring
information from one port to the other.

COPY TUNING peeks at the tuning value in the instrument on
the Chroma port and pokes it into the instrument on the Expander
port. In most cases, this tunes the two instruments together.
You may have to fine tune the Expander. This function does not
invoke an autotune. CAUTION: A SYNC 1 error can occur if you try
to copy tuning while playing notes. Do not invoke this function
while playing on the keyboard or moving any performance control.

TRANSPOSE allows you to set a transposition value between -33 and +33 semitones. When the value is inputted (follow the instructions presented when you type T) the inverse video field next to TRANSPOSE is updated. All notes in the Expander port are squelched and any future attacks, releases and pressure commands are offsetted by the transposition value.

UP 1 OCT sets the transposition value to +12 and updates the inverse video field near TRANSPOSE.

DOWN 1 OCT sets the transposition value to -12 and updates the inverse video field near TRANSPOSE.

CLEAR TRANSPOSE sets the transposition value to 0 and updates the inverse video field near TRANSPOSE.

1, 2, and 3 are programmable preset transposition values that can be selected. The transposition value and the inverse video field near TRANSPOSE is set according the value shown in inverse video near the selection (1, 2, or 3). These values are retained, even if you exit to the main menu and come back to H - CHROMA<>EXPANDER. They are set to zero when the computer is powered up.

PROGRAM MODE is entered to set the above mentioned programmable transposition presets. When P is selected, the computer will ask for a preset number, then a transposition value. If you type <RET> when asked for the preset number, the PROGRAM MODE will be aborted. The inverse video field near the preset number will be updated.

If you enter H and the Sequencer immediately returns to the main menu, it is likely that the footswitch is not connected or the CHECK FOOTSWITCH parameter in RECONFIGURE has not been set properly (see CHapter 9).

During the control of this program, the normal Chroma SET-SPLIT functions affecting interface communication on each instrument operate as normal. They are listed below for your convenience:

SET SPLIT NUMBER	FUNCTION
16	Turn OFF Performance Information
17	Turn ON Performance Information
18	Turn OFF Panel Information
19	Turn ON Panel Information
34	Turn OFF Pressure Information
35	Turn ON Pressure Information
20	Send Current Program 0

In addition, the normal Lower Function switch settings on the Polaris effect the transfer operation. They are listed below for your convenience:

                LF C 5   - Chroma Program Switch (Polaris revisions 7
                                  and above only)
                LF C 7   - Chroma Panel Switch
                LF C 11   - Send the Main Instrument Workspace (Prog 0)
                LF B 4   - Main Instrument Chroma Out Switch
                LF B 5   - Link Instrument Chroma Out Switch
                LF B 6   - Sequencer Instrument Chroma Out Switch

     LF B 4-6 are all turned on when entering the H menu selection. They are not exactly Performance Switches, but are Output Switches controlling the transmission of all data (performance, as well as program and panel data). See the Polaris user's manual for more details.

Multi-Instrument:

     The ^I - INSTRUMENTS selection allows you to play up to 8 different instruments from the Chroma keyboard, where previously only two instruments could be played.
     You can define Chroma port and Expander port instruments according to program numbers. An editing mode is provided to allow you to easily change program, volume, transposition, keyboard range, and performance control routing/filtering.
     In addition, the configuration that you define can be saved to disk and can even be assigned to one of the program selection switches on the panel of the instrument connected to the Chroma port.
     Each of the eight instruments are displayed in the table at the top of the screen with pertinent information under seven headings. At the bottom of the screen is the INSTRUMENTS main menu. The selections are described below:

                        E - Edit/Create

     This selection allows you to set up a group of instruments from scratch or to change existing instrument parameters. The edit/create submenu is stored on disk so the program will load from disk when you depress `E'. You make changes or additions to the instrument table by placing the inverse cursor over the area you wish to modify.

To define (create) an instrument, put the cursor over the
`INSTR #' column, then select a program on the instrument
connected to either the Chroma or Expander port. The software
will automatically set the port and program fields of the
instrument table. Use this same method to change the program
number of an existing instrument.

The volume will be set to maximum when the instrument is
defined. With the cursor over the volume field, depressing `U'
or `D' will raise or lower the volume. To change the program
number of an existing instrument without effecting the volume,
put the cursor over the program number field and enter the
program number manually.

To undefine (clear) an instrument, put the cursor over the
`INSTR #' column and depress `Z'.

There are three modes of playing the group of multi-
instruments defined (which is selected by depressing `M'):

    Unison   - Stacks all the instruments on one key

    Ordered   - Assigns a different instrument to each key
                in the order in which it is played

    Split   - Assigns an instrument to a range of keys

When ordered and split modes are entered, you will notice
that instrument 0 is automatically undefined. Instrument 0 is
the main instrument (the keyboard) of the device on the Chroma
port. It is automatically undefined to silence the keyboard in
split and ordered modes. You can redefine instrument 0 manually
(as above) if desired or you can assign instrument 0 to the
Expander port to eliminate this problem.

In split mode you can access the splitlo (lowest key for
this instrument), splithi (highest key for this instrument), and
transpose columns. To assign key boundaries, put the cursor over
the desired split column and play a key on the instrument
connected to the Chroma port. Split points can overlap with
other instruments. The key range can be only one note by setting
splitlo and splithi to the same key. You transpose the
instrument in semitones by placing the cursor over the transpose
column and depressing `U' or `D'.

When split mode is entered for the first time, the split
points are all set to the two ends of the keyboard. By
depressing `K', the split points will be divided equally across
the keyboard (regardless of the instrument connected to the
Chroma port).

F - Set Filters
(accessible from the Edit/Create submenu)

This allows you to selectively choose which performance controls will effect which instruments. To toggle the filter on or off, place the cursor under the desired performance control column in the instrument row and depress <RET>. An `X' displayed means the control is active, `0' means the control is inactive (this performance control command is filtered out of the data stream). Filters cannot be set for instrument 0 if it is assigned to the Chroma port. The keyboard and performance controls are always sent to instrument 0 inside the Chroma port device. This is not a problem if instrument 0 is assigned to the Expander port.

G - Get Setup

This selection retrieves a single multi-instrument setup from disk which you have saved previously. Type the name of the setup when prompted.

D - Disk Delete

This selection allows you to delete a setup from the disk. Remember, file type checking is not performed on disk delete operations. Be careful to input the proper name.

F -Fast Load

Fast Load is a special mode whereby you can assign up to 5 single multi-instrument setups to instrument panel switches of your choice. Once loaded, you access a multi-instrument setup by merely depressing the instrument's panel switch. This will automatically setup up the multi-instrument instead of selecting the usual program. The 5 setups are stored on disk under the name of FAST.LOAD.SET. You build this file from the S-Save Setup selection described below. The computer will beep if you select F -Fast Load and there is no FAST.LOAD.SET file on disk.

Once Fast Load mode is entered, the panel numbers that access the multi-instrument setups will be displayed at the bottom of the screen. You can freely select between multi-instrument setups and normal programs from the panel.

S - Save Setup

This selection saves multi-instrument setups to disk. You
are given a choice between saving the current setup in the Fast
Load Set (see above) or as a single multi-instrument setup. You
may wish to do both.

When you `SAVE SETUP TO DISK' you give it a name as you
would a sequence or program group. You can then retrieve it
later via G - Get Setup.

If you decide to put this setup in the Fast Load Set, you
first select its position in the set (this allows you to write
over unwanted setups), then give it a name for future reference,
then select a panel number on the instrument connected to the
Chroma port. This panel switch will be the panel switch that
accesses the setup under Fast Load mode. Once these operations
are performed, the FAST.LOAD.SET file will be automatically
updated or created on the disk.

Parameter Display:

The U - PARAMETERS selection will display the parameters of
a Chroma program on the CRT screen in two (2) pages. Both the A
and B parameters can be displayed. When the parameters are
changed on the Chroma, the values displayed on the CRT screen are
updated. When the Chroma program is changed, all values are
updated to reflect the new values.

The items to be displayed are controlled by various single
key depressions. P toggles between displaying Page 1 (parameters
1-26) and Page 2 (parameters 27-50). A toggles between
displaying A parameters and not displaying them. B toggles
between displaying B parameters and not displaying them.

Pressing <ESC> exits Parameter Display and returns the user
to the Sequencer main menu.

Support for the Expander port is not provided at this time.
If the instrument connected to the Chroma port is not a Chroma or
Chroma Expander, this menu selection will display an error
message and return to the main menu.

Reinitialize:

The I - REINITIALIZE selection reinitializes the Sequencer
and, to some extent, both the Chroma and Expander. It attempts
to re-establish communication with the instruments and, if the
instruments are not totally confused, will sync them to the
Sequencer. It also sends ID commands to each port and finds out
whether they are a Chroma, Chroma Expander, or Polaris and their
software revisions. The Sequencer does not tell you what it
found, but you can view the result from RECONFIGURE, VIEW CURRENT
STATUS (see Chapter 9).

Comments:

The ^U0 selection is one of the USER UTILITY BANK 1 programs provided with the Sequencer. It allows the user to read or write a 115 character comment in the sequence. This is useful for indicating the name of the program group that was used to record the sequence and as a quick reference to the setup.

When run, the program presents the user with the following menu:

```
        USER COMMENT PROGRAM

            S - STORE A COMMENT
            R - READ A COMMENT
        <ESC> - MAIN MENU

        PLEASE SELECT...
```

When R is selected, the Sequencer will display the current comment then ask the user to press any key to continue. When a key is depressed, the COMMENT menu above is displayed again. The comment displayed may contain non-alphanumeric characters if the comment field is empty.

When S is selected, the Sequencer asks the user to type in the comment followed by a <RET>. There is currently a 115 character limit. If the comment is too long, the program asks you to type it in again.

If <ESC> is selected, the program returns to the Sequencer main menu.

The Sequencer provides a way of automatically loading program group files when loading sequences. If the phrase "CHROMA PORT USES filename," is found in the comment field when getting a sequence, the Sequencer will attempt to load the program group with that filename. Likewise, if the phrase "EXPANDER PORT USES filename," is found, the Sequencer will attempt to load that program group into the Expander port. The comma after the filename is required. For more information on this feature, see Chapter 7.

Interface Test Program:

The ^V0 selection is one of the USER UTILITY BANK 2 programs provided with the Sequencer. It allows the user and service technician to test the interface PC card. This program is described fully in APPENDIX L.

ADC Adjustment Program:

     The ^V1 selection is also one of the USER UTILITY BANK 1
programs provided with the Sequencer.   It allows the user to
test and/or adjust the ADC pedal input range.
     When selected from the main menu, the program continuously
displays the current ADC pedal input value on the screen in
decimal. The pedal is properly adjusted if 0 is displayed when
the pedal is in 'heel' position and 255 is displayed when the
pedal just reaches the 'toe' position.
     If the ADC needs adjustment, push the pedal to 'heel'
position and adjust trimpot R29 (the one closest to the rear of
the computer) for 0 display. You should first adjust R29 until
you start seeing 1's then back off until it is always 0. Then
push the pedal to 'toe' position (all the way down) and adjust
trimpot R25 (the one closest to you) for 255 display. You should
adjust from 254 until the display always reads 255. Then push
the pedal to 'heel' position and readjust for 0. For further
understanding, see APPENDIX O, HARDWARE DESCRIPTIONS AND
SPECIFICATIONS.
     Type a <RET> to exit back to the Sequencer main menu.

Hidden Menu Selections:

     There are three (3) functions available from the main menu
that are not displayed because they are very infrequently used
and menu space is at a premium.
     One such selection is ^X - DELETE MEASURES. This function
deletes all measure commands and resets the sequence to as if
there was never a click track. This is a memory saving function.
Unfortunately, it eliminates the possibility of setting endpoints
and makes it difficult to make the sequence loop in time. See
APPENDIX E for more information.
     Another selection is ^Y - SCRUNCH. This is also a memory
saving function. Invoking it reduces timing resolution from two
time values (1 time value if using an External or Single Step
timer source) to six time values. These are not TIME INCREMENTS,
but actual time values. See APPENDIX E for more information.
     The third selection not displayed in the menu is ^W -
PRESSURE RECORD. This is just like normal recording, except that
pressure information coming from the Chroma port is remembered.
See Chapter 5 for more information regarding this selection.

ERROR CONDITIONS AND CODES

There are five different types of error conditions that can occur in the Sequencer:

(1) Those that are fatal, meaning those conditions in which there is a possibility of loosing data. Continuing to operate on a sequence after this type of error is likely to result in other errors.

(2) Those that are not fatal but may or may not stop the current operation.

(3) Errors that occur in the Editor, such as syntax errors.

(4) File Management or disk errors.

(5) Power up error conditions.

Fatal Errors:

1 SYNC ERR   The Sequencer was expecting an echo response from Chroma but got something else. This condition can occur in many points in the software.

10 SYNC ERR   This will occur if the Chroma does not correctly echo the PANEL SWITCH OFF command following a record operation.

12 SYNC ERR   This will occur if the Chroma does not correctly echo the STATUS1 command preceeding a record operation.

6 DEFINITION ERR   This will occur if a command encountered by the Sequencer references a Chroma instrument that has not been previously defined.

These fatal errors are generally caused by communication problems with the Chroma. If it is caused by a glitch in the powerline or some other nonreoccurring anomaly, doing a Set-Split 50 on all instruments followed by an I - REINITIALIZE from the Sequencer may solve the problem. Check the port status in RECONFIGURE and clear the sequence before proceeding. If this does not help, try powering up the instruments and the computer according to Chapter 2. If all else fails, please contact the Fender Service Department.

NonFatal Errors:

Four conditions can occur that are not really errors but are exceptions to the normal. These are:

(1) Sequence Memory Full- you have used all available memory for this sequence. Data recorded up to that point is still intact. Recording is terminated and the Sequencer returns to the main menu.

(2) Out Of Instruments- you are attempting to output more than 8 tracks to the instrument on the Chroma port. The track that put you over the limit will be muted and the Sequencer will continue to record or play. If the AUTO REROUTE is enabled this condition cannot occur because up to 8 tracks are automatically rerouted to the Expander whenever more than 8 tracks are sent to the Chroma.

(3) No Expander- You have attempted to send a track to an Expander port that is not on line. The track will be muted and the Sequencer will continue to record or play.

(4) Clean Sequence- If you try and perform an operation that cannot be completed because there is no sequence in memory, the Sequencer will return to the main menu.

Other Nonfatal Errors Are:

ERRCOD CODES: 10-call upon SEARCH without an EOS command at start
              of sequence.

             11-illegal SEARCH OPERATION call type.

             18-measure not found in monitor.

These three errors should never occur. If they do, please call the Fender Service Department.

Editor Syntax Error Codes:

    12 - unrecognized command in disassemble routine.

    13 - syntax error in entering command in the editor.

    14 - user attempts to change Define command in editor. This
         is currently illegal.

15 - user attempts to delete End Of Sequence (EOS) or Begin
     Of Sequence (BOS) command, insert before EOS or BOS, or
     change EOS or BOS. These operations are currently
     illegal.

16 - track out of range or not in edit mode in editor.

Disk Errors:

These errors can occur at anytime the Sequencer attempts to
access the disk drive.

3- Write Protected : Cannot write, please remove Write
   Protect tab from diskette.

4- End of Data Error : Diskette is damaged.

5- File Not Found : You have specified a nonexistent file.

6- Volume Mismatch : Diskette is missing.

7- I/O Error : Diskette is missing or damaged.

8- Disk Full : Please create another data diskette (see
   Appendix M).

9- File Locked : Please unlock file first (see DOS manual)

10-Syntax Error : DOS error.

11-No Buffers Available : DOS error.

12-File Type Mismatch : You have specified the wrong type of
   file for this operation.

13-Program Too Large : DOS error.

14-Not Direct Command : DOS error.

15-Unrecognized Error : DOS error.

Other Disk Errors:

    The Sequencer will print specific messages when the data
diskette is full, if the overlay called upon was not found or the
sequence or program group file was not found. Various utility
programs provided with the Sequencer may have their own disk
error indications (such as displayed messages, beeping, etc.).
See the appropriate section of this manual for any error
discussion.

Power Up Errors:

    The Sequencer will attempt to talk to a Chroma instrument on
both the Chroma port and the Expander port. If communication on
the Chroma port does not occur the Sequencer will tell the user
to check the cables and try again. If communication occurs but
the instrument does not have a keyboard and/or the software
revision of the instrument is higher than expected, it will tell
you so and ask if you want to continue. If communication does
not ocurr on the Expander port, the Sequencer merely tells the
user that the Expander is 'not on line'. If it is on line, but
the instrument is not neccessarily compatible with the Sequencer
and/or the software revision of the instrument is higher than
expected, the Sequencer will tell the user and asks if he wants
to continue.

    As you can see, only a Chroma or Chroma Polaris should be
connected to the Chroma port (at this time). This is because the
Chroma or Chroma Polaris can send key depression data and it is
the Chroma port that is referenced when the Sequencer records a
track. The Expander port can except either a Chroma, Chroma
Expander, or a Chroma Polaris. We can not say that all future
products will be compatible with this Sequencer, but the large
majority of them should be compatible after little more than a
diskette update.

GETTING MORE NOTES OUT OF THE SYSTEM

This section deals with the finite limitations on note storage capacity. An obvious way to increase this capacity is to provide for RAM expansion. This revision of the Sequencer allows for expanded RAM, which is fully explained in APPENDIX F.

It seems that no matter how much memory a system has available for storage, there will be a need for more. It was with this in mind that we have provided two memory saving functions to be performed after most of a sequence has been recorded. One function reduces timing resolution and the other deletes measure commands. Both of these functions remove data that may still be valuable if you intend to record more than about one more track.

^Y-SCRUNCH   Reduces timing resolution from two time values (1 time value if using an External or Single Step timer source) to six time values. These are not TIME INCREMENTS, but actual time values. This may result in fewer 3 byte time commands stored in the sequence file.

^X-DELETE MEASURES Removes all 3 byte measure commands and resets the sequence to as if there was never a click track. This eliminates the possibility of setting endpoints and makes it difficult to make the sequence loop in time. This function can only save a few notes worth of memory, so think about what you are giving up for it.

NOTE: ^X - DELETE MEASURES is not displayed in the main menu, but is still available as a selection from any menu page.

In addition, the Quantizer (see Chapter 6) will most often reduce the amount of memory used by a sequence, particularly if there are many tracks.

Memory Saving Techiques:

A Chroma instrument outputs Performance Control information in duplicate whenever a linked program is used. It doesn't matter if it's link upper, lower or unison. If the linked program does not make use of these performance controls then it is a waste of memory space when you record. To maximize the use of available memory space it is wise to be aware of this situation when it occurs and record the two tracks separately.

The Chroma instrument will output all notes that are
pressed, even if the voice is monophonic. In LINK UNISON mode,
all attacks, releases and performance control changes are
duplicated as instrument 0 and instrument 1 commands. Therefore,
if you are recording a LINK UNISON program and the LINK is a
monophonic program, you are wasting memory. It would be better
to record each track separately and play one note at a time with
the monophonic program.

The Sequencer stores a 3 byte Time Command before an Event
Command if that event occurred more than 2 timer states after the
previous event (1 timer state if using an external or single step
clock). If you play your chords more precisely and record
subsequent tracks more accurately, the Sequencer will use less
memory space. In fact, you can use the Editor to remove closely
spaced time commands. This has the added benefit of making notes
of a chord sound more simultaneous. In addition, the Quantizer
(see Chapter 6) will most often reduce the amount of memory used
by a sequence because it will reduce the number of Time Commands
between the notes of an inaccurately played chord.

The Pressure Sensor Option will work with the Sequencer when
it becomes available for your Chroma. The amount of data
generated by the pressure sensor is analagous to a separate pitch
bend lever for each key. Therefore, memory will be used up very
quickly when recording with pressure. It is for this reason that
we have elected to keep pressure recording separate from the
normal record mode, as indicated in the main menu and Chapter 5.

NOTES ON EXPANDED RAM

The Sequencer features expandable note storage capacity with the addition of RAM hardware. This Appendix details equipment capability and installation procedures. It also outlines the advantages and disadvantages of expanded RAM and breifly describes the memory structure.

RAM Card Requirements:

Currently only two (2) commercially available RAM cards are compatible with this version of the Sequencer:

Model: Saturn 64K or 128K Card

Manufacturer: Titan Technologies, Inc.
               P.O. Box 8050
               Ann Arbor, MI 48107
               (313) 662-8542

Model: 128K card

Manufacturer: Alphabyte Computer Products
               31304 Via Colina
               West Lake Village, CA 91362
               (213) 706-0333

How To Install Expanded RAM:

To install the expanded RAM feature, you must first install the RAM card in the computer according to the card manufacturer's instructions. You should then install the Interface Kit according to Chapter 2. Once these two steps have been performed, you must change the RECONFIGURE setup to use expanded RAM, save the setup under the name of MAIN SETUP, then reboot. The following is a detailed procedure for changing and saving the setup to install expanded RAM:

1. Select X (RECONFIGURE) from the main menu. After the Sequencer loads that overlay, it will print another small menu. To thoroughly understand RECONFIGURE, you should read Chapter 9. It is not necessary at this time, however, if you carefully follow these instructions.

2. Select C (CHANGE SET UP) from this RECONFIGURE menu.

3. Keep typing <RET>, which means DEFAULT, until 'EXPANDED
   RAM? N' is displayed on the screen. At this point,
   instead of typing <RET>, type Y.   The Sequencer will
   then ask you to type in the slot number of the RAM
   card. Type in the slot number then <RET>. After that,
   you should be back at the RECONFIGURE menu.

4. At this point, type V for VIEW CURRENT STATUS and check
   to see that the expanded RAM is in fact set up for the
   slot you intended. The screen will display '0 SECTORS'
   because the expanded RAM is not yet installed. After
   you are satisfied that this is the case, type any key
   to get back to the RECONFIGURE menu and continue with
   step 5 below. If you are not satisfied then type any
   key to get back to the RECONFIGURE menu and goto step
   2.

5. Type S for SAVE SET UP. When it asks you for the name of
   the set-up file carefully type MAIN SETUP then <RET>.
   Make sure that you type one space between MAIN and
   SETUP.

6. After this is done, you are back at the RECONFIGURE menu
   so type <RET> to exit into the main menu.

7. Turn OFF the computer and power the system up as
   described in Chapter 2.

8. When the system is rebooted, the computer should display
   'EXPANDED RAM INSTALLED (112K)...' before displaying
   the main menu. If you have installed a 64K card, the
   computer should indicate one-half of 112K, or 56K.

Positive Effects Of Expanded RAM:

The 64K cards will give you 4000 notes, the 128K cards will
give you 8000 notes, as opposed to 1700 notes under nonexpanded
mode. These are approximate capacities and the actual note
capacity will depend on:

a). the type and number of performance controls (levers,
    pedals, and especially pressure use a lot of memory),

b). the type of music (single line melodic stuff takes more
    memory than block chord stuff), and

c). to a slight extent, the number of tracks in the
    sequence (the more tracks, the greater the possibility
    of simultaneous events).

As a major side benefit, the disk (see Chapter 7) and track directory editing functions (see Chapter 6) can be accessed quicker because they will be 'locked' into memory. Systems running under nonexpanded mode have to access the diskette for these overlays.

Negative Effects Of Expanded RAM:

An obvious disadvantage of expanded RAM is that you must purchase additional hardware to take advantage of the improvement. This section, however, mentions some of the not-so-obvious disadvantages.

The more memory used by a sequence, the more time it takes to perform operations on the sequence. This becomes quickly apparent when a track directory is performed, since this requires gathering data from the sequence. It also can become a problem when looping between endpoints other than the beginning and ending of a sequence. In addition, the more memory used by a sequence, the longer it takes to save/load the sequence to/from the diskette.

In the old Rev 5 Sequencer release, it was neccessary to convert REV 4 sequences to REV 5 sequences indirectly because of the expanded RAM capability. The process of conversion requires an overlay call from the Drive 1 diskette if the software was running under the nonexpanded mode (the overlay is locked in RAM if under expanded mode). The result is that single drive systems running under nonexpanded mode cannot load REV 4 sequences. Effectively, then, the Rev 5 version of the Sequencer almost requires two disk drives. Since only Rev 5 and Rev 6 sequences can be loaded by Rev 6 Sequencer software, this problem is not present in the current Rev 6 software.

Expanded RAM Structure:

The expanded RAM sequence structure is essentially the same as that described in APPENDIX B, with the exception of where the data is stored and the physical representation of the sequence queue. This information is present in this Appendix for reference only. It is not necessary that you understand this to operate the Sequencer.

The expanded RAM sequence queue structure is basically that of a simple virtual memory paging system, using the RAM card similar to disk memory.

The sequence queue has been replaced with a similar structure centering around two small buffers in non-switched RAM. One buffer contains up to 256 bytes of sequence data, one byte of which is pointed to by the output pointer. The other also contains up to 256 bytes of sequence data, with the next free space being pointed to by the input pointer. At all times, the pointers point to data in non-switched RAM.

When the buffer boundaries are met, 'sectors' from the RAM

card are loaded into the buffer (or stored into the RAM card from
the buffer). A bank and sector counter is maintained for both
input and output.

The expanded RAM capability is implemented in assembly
modules, so that the system could run in nonexpanded mode and
future RAM cards could be supported with minimal changes in the
code. It is not possible at this time for users to write the
drivers and bind them into the Sequencer.

IF YOU NEED SLOT 5 FOR SOMETHING ELSE

Some peripherals for the Apple II are slot dependent, which means they must be installed in a particular slot. The Interface PC card is not such a peripheral. You must, however, first power-up the system with the card in slot 5. If you need slot 5 for something else, take that something else out of slot 5 temporarily and perform the steps outlined in the Installation section (Chapter 2) then do the following:

1. Select X-RECONFIGURE from the main menu. After the Sequencer loads that overlay, it will print another small menu. To thoroughly understand RECONFIGURE, you should read Chapter 9. It is not necessary at this time, however, if you carefully follow these instructions.

2. Select C-CHANGE SET UP from this RECONFIGURE menu.

3. Keep typing <RET>, which means DEFAULT, until it tells you that the Interface Slot is 5. Instead of typing <RET>, type the number of the slot that you want to use for the Interface PC card then type <RET>. After that, keep typing <RET> until you get back to the RECONFIGURE menu.

4. At this point, type V for VIEW CURRENT STATUS and check to see that the Interface Slot is truly set up for the slot you intended. After you are satisfied that this is the case, notice the disk controller slot number for future reference and type any key to get back to the RECONFIGURE menu. If you are not satisfied then type any key to get back to the RECONFIGURE menu and goto step 2.

5. Type S for SAVE SET UP. When it asks you for the name of the set-up file carefully type MAIN SETUP then <RET>. Make sure that you type one space between MAIN and SETUP.

6. After this is done, you are back at the RECONFIGURE menu so type <RET> to exit into the main menu.

7. Turn OFF the computer and install the PC card in the desired slot (see Chapter 2).

8. Power the system up as described in Chapter 2.

BOARDS, CHANNELS, INSTRUMENTS and TRACKS

The Chroma instruments and Sequencer can produce very complex sequences if they are used with a knowledge of the Chroma channel architecture. This Appendix will discuss some topics that are relevant to channels and logical instruments in a computer interface environment. It should be read and understood by the serious user, particularly one who is having trouble with `note stealing'.

The Chroma Instruments As Viewed From The Computer Interface:

From the Chroma Computer Interface, the instrument looks like one physical instrument containing eight (8) logical instruments. Each logical instrument can play a separate sound and is allocated a portion of the physical instrument's sound generation resources. This allocation is performed by the physical instrument's computer, not the external computer connected to the interface port.

The sound that `defines' a logical instrument is in turn defined by a data structure called a program. The program data structure resides in the physical instrument, not the computer connected to the interface port. Certain parameters of the program (keyboard algorithm, for example) effect the sound generation resource requirements for an instrument defined by that program.

The Interface Command Set (see APPENDIX I) supports the eight channel concept. The three least significant bits of logical instrument command opcodes denote the instruments. Instruments are numbered from 0 to 7, with the synthesizer's keyboard normally using instrument 0. This keyboard instrument is called the 'main instrument'. The keyboard is also assigned instrument 1 if the current program has a link. This linked keyboard instrument is called the 'link instrument'. The Chroma Polaris synthesizer can also define an instrument called the 'sequencer instrument', which is logical instrument 2. This instrument is connected to the Polaris' internal single track sequencer. All other instruments can be defined only through the external Chroma Computer Interface.

The way the Sequencer records is that it inputs Instrument 0, 1, and 2 commands from the physical Chroma instrument and assigns track numbers. These track numbers, in turn, are assigned available logical instrument numbers when playing the sequence. The Sequencer can, therefore, play up to eight tracks at a time on each interface port.

Throughout this manual, tracks and logical instruments are used interchangably unless noted. Tracks refer to logical instruments defined by the Sequencer. Track numbers do not necessarily correspond directly to logical instrument numbers, however.

Resource Allocation Performed By the Physical Instument:

It is preferred to view the Chroma and Chroma Expander synthesizers as eight channel synthesizers with provisions for 16 channels within certain limitations. Each of the eight channels has two oscillators, two filters and two amplifiers that reside on one `board'. Sixteen channels are available only when the program patch parameter is 0.

It is important to understand how the Chroma allocates channels and boards among instruments and to understand what happens when the user plays more notes than can be sounded with the number of channels available for that instrument. Channel and board allocation for each track depends on the number of tracks currently defined and the Keyboard Algorithm and patch parameter of the programs that are defined by the tracks (instruments).

Monophonic logical instruments are always assigned one channel and one board. If the patch parameter for the program is 0, then only one oscillator/filter/amplifier on that board is used. If the patch parameter is non-zero then all hardware on the board is used.

The number of channels and boards assigned to polyphonic logical instruments depends upon the number available at the time of instrument definition. Essentially, the polyphonic instruments share the available channels.

For the purposes of initial explanation, let us assume that all programs, monophonic and polyphonic have a patch of non-zero. This is reasonable since most people prefer the sound capabilities of those patch configurations. A single polyphonic track, just as an unlinked passage played from the keyboard, is assigned all eight channels and uses all the hardware on each board. If there are two polyphonic tracks, each is assigned four channels (and four boards). If there are an odd number of polyphonic tracks, then the Chroma assigns channels as evenly as possible but gives priority to the lowest instrument numbers.

In the case of the Sequencer, this means that the tracks that start earlier in time are given more channels if the total number of tracks is odd. For instance, if three polyphonic tracks are defined, the first two have three channels and the third one has two channels.

The Sequencer marks the beginning of a track with a `define instrument' command and the ending with an `undefine instrument' command. Keep in mind that the first track may not be track #1, since another track can be recorded with its first note occurring before track #1 starts. Instruments are assigned in the order of define command occurrance during playback. Every time a define or undefine command occurs, channels are reallocated. If all tracks are defined as polyphonic, then the number of channels allocated to that instrument are likely to change during reallocation. If a track is monophonic, it will not change because monophonic instruments are always assigned one channel.

This is a good place to explain what happens when the musician or the Sequencer tells the Chroma to play more boards than it has available. If you play the Chroma keyboard you will notice that if the program patch is nonzero and you try to play more than eight notes, then the Chroma will release the first (oldest) note played. If you do the same thing with a program that is linked lower with another program and both programs have a patch parameter of nonzero then you can play only four notes on either side of the split before the Chroma "steals boards." The Chroma will not steal boards between instruments.

The same thing occurs with the Sequencer, but the effect is much more pronounced since many more instruments are defined and each instrument ends up with fewer channels. When channels are reallocated and the musician or Sequencer asks for more notes in that track than is possible, then the Chroma releases the oldest note in that track.

If you digested the above description of channel allocation, you must realize how important it is to know before hand how many tracks you will record and whether these tracks will be polyphonic or monophonic.

To make the situation a little more complex, consider tracks that are defined as programs that have patch parameters of zero. This means that each note uses one oscillator/filter/amplifier. If the Keyboard Algorithm is monophonic, one half of the board is wasted. If the program is polyphonic and only one instrument is defined, then you can play 16 notes before the Chroma steals boards. If there are three instruments defined and the first is polyphonic with patch 0, the second is polyphonic with patch nonzero and the third is monophonic with patch 0 or nonzero then the first instrument can play eight (two times four) notes, the second can play three and the third can play one. If you play more than eight notes in the first instrument but only one in the second instrument, the Chroma cannot use channels allocated to the second instrument and will release the oldest notes played by the first instrument.

Suggestions For Getting The Most Out Of Chroma Channels:

With the above in mind, one can make a few suggestions about getting maximum utility from the Chroma interface system:

(1) Lay down monophonic tracks first. Usually these are the bass or other rhythmic lines. You will have a tendency to lose the beat if your rhythm tracks lose notes due to board stealing. The programs used must be monophonic programs.

(2) Use monophonic tracks as often as possible. This gives you complete control of the board allocation.

(3) If there are long periods within a track that nothing is
    being played, it is better to stop the recording at that
    point and record the next segment on another track.
    This frees the boards for other tracks during the period
    of silence.

Chroma Polaris Considerations:

The Polaris synthesizer has only six dual-oscillator
channels. Its logical instrument definition occurs dynamically,
on a note per note basis instead of in response to a new define
command. Channel allocation, therefore, is not dictated by the
number of tracks defined, but the total number of notes in
process. This is infinitely better for multi-track sequencing.
Also, the channel resources required per note are not effected by
any program data parameter (the Polaris does not support a
monophonic keyboard algorithm).

The keyboard algorithm implemented in the Polaris is to
steal the last note played if it has to steal. This preserves
long sustaining notes, which are often important bass notes.

Therefore, the suggestions mentioned above for the Chroma
are not applicable to the Polaris.

SOFTWARE ANOMALIES

This section outlines the differences in behavior between Chromas, Expanders, Polarises and Sequencer software diskettes of different revision levels. It also touches on software bugs and the bug reporting procedure that we would like you to follow.

If you discover a software anomaly in one of our instruments or the Sequencer software, or if you have a comment or suggestion, please contact Fender Musical Instruments. We prefer that you make the bug report in writing, since this will maximize the chance that a fix or suggestion will be included in subsequent revisions. Many worthwhile features of our products were suggested by our customers.

Chroma and Expander Software Revisions:

Please note that the Interface Revision Number (IRN) is returned in response to the Identification command and that this number is not the same as the Software Revision Number (SRN) as imprinted on the EPROMS inside the instrument.

The SRN revision levels are described in reverse order, starting with the current revision. Each revision description outlines the differences between that revision and the subsequent revision above it.

REV 14 CHROMA:

This is the current revision as described in this manual. The IRN is 3. All bugs described below have been fixed.

Commands relating to pressure are now fully implemented.

The Unlock command will disable the Poke and Poke 2 Bytes commands if the last two bytes of the command are sent in the wrong order (FF 00).

In addition, four (4) new commands relating to Set-Split functions have been added:

Set-Split 46   F8

This command is sent by the Chroma whenever the user does a Set-Split 46 on the Chroma's panel.

Set-Split 47   F9

This command is sent by the Chroma whenever the user does a Set-Split 47 on the Chroma's panel.

Set-Split 48   FA

This command is sent by the Chroma whenever the user does a Set-Split 48 on the Chroma's panel.

Set-Split 49   FB

This command is sent by the Chroma whenever the user does a Set-Split 49 on the Chroma's panel.

REV 13 CHROMA:

This is an internal release only. The IRN is 3.

REV 12 CHROMA:

In this revision (IRN 2), the Unlock command works fine, but there is no way to Lock after Unlocking. Also, this revision did not include the pressure sensor commands. This results in the following restrictions:

The Pressure Switch Off and Pressure Switch On commands are treated as No Operations. They are not echoed.

The Restore command does not echo a Pressure Switch Off command.

The pressure byte in all Attack commands sent by the Chroma is 0. The pressure byte in all Attack commands received by the Chroma is ignored (although it must be present).

Two bugs were found in this revision:

If a link is in effect and a lever or pedal is moved, the Chroma will not transmit an instrument 0 and an instrument 1 command. Instead, the Chroma will send two identical instrument 0 commands. This only applies to the Lever 0, Lever 1, Pedal 0 and Pedal 1 commands.

Varying the link balance control when the panel switch is on will cause the Chroma to send volume commands for both instrument0 and instrument1 to indicate the absolute volume relationship between the instruments. The Chroma <u>does</u> send both volume commands but the value is always the same and that value is random bearing no relationship to the actual volumes of the instruments.

REV 11 CHROMA:

This is an internal release only. The IRN is 1.

REV 10 CHROMA:

A number of bugs were found in this initial field release revision (IRN 1):

If a Footswitch command is sent to any instrument that has never been defined since power-up, it will crash the Chroma.

The Restore command does nothing to instrument 1, regardless of the link.

Although the Restore command turns off the panel and performance switch, it does not echo the Panel and Performance Switch Off commands.

Bytes coming from the Chroma occasionally get rearranged and are transmitted out of sequence. This only occurrs if the external computer makes the Chroma wait more than 100usec or so, and the Chroma starts to use its output queue. This problem is more visible at high data rates.

Sequencer Handling of Chroma Bugs and Revisions:

The Sequencer software is designed to work with instruments that have IRN's of 1, 2, or 3. The earlier reisions, however, have serious problems that cannot be overcome from the external computer end.

The Sequencer gets around the pressure recognition problem by filtering the pressure information to a port that is connected to an instrument of IRN less than 3.

The Restore command handler in the Sequencer can understand and correct the interpretation of Restore commands in <u>all</u> previous Chroma SRN's by looking at the IRN of the instrument on the Chroma port.

The pedal and lever bug in SRN's below 13 will be noticed

when you record things like pitch bends or vibrato in a link
program. The linked program will fail to be modified when the
sequence is played back.

The Sequencer makes no attempt to correct the link balance
Volume command bug in SRN's below 13. The user, therefore, will
not be able to change the relative volumes of the two tracks by
moving the Link Balance parameter during recording.

Upgrading The Chroma Instrument Software:

All it takes to bring an instrument up to the current
revision is to unplug the EPROMs and plug in new ones. This can
be done by any authorized Rhodes Chroma service center, and is
free if the instrument is under warranty. Upgrading is strongly
recommended, as old software is only old because there was
something wrong with it.

Although the Sequencer software will work with IRN's of 1,
2, or 3, Some of the earlier revisions have serious bugs (as
outlined above) that cannot be fully corrected from the external
computer's end. It is recommended, therefore, that users of the
Computer Interface Kit upgrade their Chromas with REV 14 EPROMs.

To request an upgrade from a service center, always refer to
the SRN which is printed on the EPROMs, not the IRN. Most
service centers are not aware of IRN's.

The current revision includes provision for the Pressure
Sensor Option. This does not mean that the Pressure Sensor must
be installed. The Chroma will respond to Pressure commands
whether or not the option is installed. It just won't generate
correct Pressure commands.

Polaris Software Revisions:

Please note that the Interface Revision Number (IRN) is
returned in response to the Identification command and that this
number is the same as the Software Revision Number (SRN) as
imprinted on the EPROMS inside the Polaris. The IRN/SRN of the
Polaris can also be determined by performing a LF,D,2. The sum
of the blinking LEDs after the preceeding switch sequence is
performed is equal to the IRN/SRN of the instrument.

The SRN revision levels are described in reverse order,
starting with the current revision. Each revision description
outlines the differences between that revision and the subsequent
revision below it.

Note: All Polarises in the field have Rev 3 or higher software.
Rev 4 and Rev 6 Polarises were not distributed (internal
revisions only).

REV 8 POLARIS (currently unreleased):

i)   The Chroma Interface RESTORE command now functions properly.
     In Rev 7, receipt of the RESTORE command caused subsequent
     STATUS commands to return program numbers of zero.

ii) In Rev 7, if the Polaris was in MIDI Mono mode, Note Off
     commands were interpreted as Note On commands. This bug was
     fixed in Rev 8.

iii) Rev 8 also includes fixes to bugs found in the software
     extension object section of the MIDI System Exclusive
     implementation.

iv) MIDI output running status is now reset if the output queue
     becomes empty. This solves the problem of most external
     computer MIDI sequencers not keeping track of running
     status.

v)   There is now intelligent MIDI data reduction if the MIDI
     input buffer becomes full. Certain commands (Note ON,
     Control Change, etc.) are ignored on input if the MIDI input
     buffer is close to being full. In addition, an All Notes
     Off is performed if, for any reason, the MIDI input buffer
     completely fills.

vi) The Chroma Interface DEFINE command is now implemented
     properly with regard to the Pedal Initial parameter. If a
     DEFINE command with a pedal1 parameter of zero is received,
     the Polaris gets the Pedal Initial parameter from the
     program definition instead.

vii) The LF, D, 2 diagnostic function that indicates the software
     revision was changed to indicate 8.

                          REV 7 POLARIS:

i)   In Rev 6, the interpretation of a MIDI Reset turned off the
     MIDI Output switches, turned on the Local Control switches,
     and set the MIDI Mode to Poly/Omni. Rev 7 changed the
     interpretation to match the powerup condition: Local Control
     switches turned on, MIDI Output and Mode switches unchanged.
     Rev 7 also reset the MIDI Running Status so that the next
     command always sends a Status byte.

ii) The memory full indication was changed. In previous
     revisions, the error honk was sounded and the Memory Full
     LED flashed. In Rev 7, the Memory Full LED is not flashed,
     but is turned on until the user presses another switch. Any
     switch will do and the normal function of that switch is
     performed.   In Rev 7, the memory full function is
     implemented for MIDI System Exclusive object creation and
     creation of an instrument object via either MIDI Extra
     Channels or Chroma Instrument Define commands.

iii) In Rev 6, whenever a Panel Switch Off command was received
     from the Chroma Interface, the Polaris turned off both the
     Chroma Panel Switch and the MIDI Panel Switch.   This bug
     was fixed in Rev 7.

iv) Due to many problems involving MIDI Program Changes and All
     Notes Off, Chroma and MIDI Program Switches were added and
     the function of the MIDI Panel Switch was changed.

     If the MIDI Program Switch (LF, C, 6) is on:

          Program Change commands are both transmitted and
          received. An All Notes Off is sent whenever a sequence
          is stopped or a link is cleared. A Program Change 0 is
          never sent.

     If the MIDI Panel Switch is on:

          The MIDI Program Switch is logically forced on,
          although its LED is not turned on. All Control Change
          commands are transmitted and received, including those
          related to programming parameters. All Notes Off is
          not sent; Program Change 0 is sent in its place.

     If both MIDI Program and Panel Switches are off:

          Performance data and the sustain, levers, pedal and
          performace volume Control Change commands are
          transmitted and interpreted. All Notes Off is
          transmitted and interpreted.

     Regardless of the setting of either switch, receipt of a
     Program Change 0 is interpreted as a Delete instrument
     message.

The Chroma Panel Switch functions as it always has, allowing transmission of Define, Undefine and Set Parameter commands. When the Chroma Program Switch (LF, C, 5) is on and the Chroma Panel Switch is off, Define and Undefine commands will be transmitted, but Set Parameter commands will not. All Chroma Interface commands (including Define, Undefine and Set Parameter) are interpreted upon receipt, regardless of the settings of these two switches.

v)   LF, 11 was changed to include the resetting of the MIDI running status.

vi)   A MIDI reset function was added (LF, 10) that transmits a MIDI Reset command when performed.

vii) The LF, D, 2 diagnostic function that indicates the software revision was changed to 7.

viii) The ability to view and edit the sequencer program is included in Rev 7. Pressing Upper Function Link Upper will cause the panel to display the sequencer program for editing(the program number is displayed in the Bank/Program Select portion of the control panel). This works only when the sequencer Play or Record LEDs are lit because it is only at these times that the sequencer instrument is defined. If the user selects this function while the sequencer is not playing, the program LEDs in the Bank/Program Select portion of the control panel are blank and none of the programming switches will work. In either case, the user can restore normal panel operation by depressing Upper Function. The ability to store the sequence program while editing was not added.

      To accomodate this change, the Edit Link function was changed to operate similarly when no link exists - the LEDs in the Bank/Program Select portion of the panel are blank and the programming switches do not work. The user must depress Lower Function to return the panel to normal operation.

                    REV 6 POLARIS (not distributed):

i)   Software was added to simulate a sustain footswitch release whenever an All Notes Off is received, making sure that all the notes in that channel are squelched.

ii)   In Rev 5, the D LED in the LF, D, n functions turned off whenever the number part of the function was selected. This bug was fixed.

iii) In Rev 5, performing a LF, C, 11 (sending the current program to the Chroma Interface port) crashed the Polaris if there was no Chroma instrument connected to the Chroma Interface. This bug was fixed.

iv) All Notes Off is sent over the MIDI output regardless of the MIDI Panel Switch setting. If a Program Change 0 is sent as well, the All Notes Off is sent after the Program Change 0.

v) When a link program number of zero is encountered under Edit Link, the software sets the link program number to A1 instead of crashing the Polaris. Link Program numbers could never be zero unless the user started programming the sound just after loosing the memory (or performing LF, D, 12, STOP), but this did happen on the factory set because the unit used to program the sounds had a bad 1N34A.

vi) The LF, D, 2 diagnostic function that indicates the software revision was changed to 6.

REV 5 POLARIS:

i) The delay between filter and oscillator autotune was increased to minimize the effect of filter resonance control voltage bleedthrough on autotuning the next channel's oscillator. This decreased the tendency of some of the oscillators to autotune intermittently.

ii) The memory full LED flashing was lengthened.

iii) The LF, D, 2 diagnostic function that indicates the software revision was changed to 5.

REV 4 POLARIS (not distributed):

i) The master volume was turned down during autotune.

ii) In Rev 3, sometimes the program work space was not reset properly after autotune. It was noticed mainly when resonance was set at full and/or sync was on. This bug was fixed.

iii) The MIDI Out and MIDI Mode switches were made non-volatile.

iv) In Rev 3, there was a bug in the pedal adjustment correction (LF, A, 8). This bug was fixed.

v) The keyboard scanning timer was changed from an 8-bit to a
    16-bit counter. This prevented the tendency for the counter
    to wraparound, causing abnormally loud notes. This was most
    often noticed when playing black keys softly.

vi) The LF, D, 2 diagnostic function that indicates the software
    revision was changed to 4.

Sequencer Handling of Polaris Bugs and Revisions:

    The Sequencer does not attempt to accomodate bugs in the
Polaris prior to REV 5. In addition, current program
interrogation bugs in the REV 5 Polarises are also not
accomodated. See next section below.

Upgrading The Polaris Instrument Software:

    To upgrade a Polaris requires unplugging the EPROMs,
plugging in new ones, and performing a software adjustment
procedure. This can be done by any authorized Fender Service
Center, and is free if the instrument is under warranty.
Upgrading is strongly recommended.
    The Sequencer software will work reliably with IRN/SRNs of 8
and above only. Some of the earlier revisions (3 and below) have
serious bugs (as outlined above) that cannot be fully corrected
from the external computer's end. The Sequencer can work with
revision 5-7 Polarises, but some unreliability occurs in
interogating the current program number from the Polaris (because
of its handling of the RESTORE command). It is recommended,
therefore, that users of the Computer Interface Kit upgrade their
Polarises with at least REV 8 EPROMs.
    To request an upgrade from a service center, always refer to
the SRN which is obtained by performing a LF,D,2. The sum of the
blinking LEDs after the preceeding switch sequence is equal to
the SRN of the instrument.

Sequencer Software Revisons:

    The Sequencer revision levels are described in reverse
order, starting with the current revision. Each revision
description outlines the differences between that revision and
the subsequent revision below it. As new revisions are added,
bugs discovered in previous revisions are detailed in their
respective sections.

REV 6 SEQUENCER:

Rev 6 features full support of the Chroma Polaris (except PARAMETER display). All functions, including record, playback, editing, syncing, program storage, and CHROMA:EXPANDER transfer are functional. An additional utility has been added for Polaris sequence storage. Track information displays/inputs are instrument specific, meaning that program numbers for tracks going to a Polaris are displayed in the Polaris format (i.e. A1, B12). Program numbers inputted are A1, B12, etc. as well. The Sequencer is now capable of recording a Polaris sequence in real-time while simultaneoulsy recording main and link keyboard and performance events.

Multi-Instruments has been completely rewritten into a very powerful perfomance utility. It incorporates parameters for keyboard range, performance filters, and Expander support. Disk storage/retrieval has been added. In addition, you can map five multi-instrument setups to any five Chroma or Polaris panel switches for instant stage access.

The Arpeggiator (External Trigger) now supports two independent arpeggios for main and link. Also, you can now add octaves to arpegiated chords.

We have added a selective post-processing quantizer. The quantizing keeps the notes the same length; it just moves them in time. You can specify the track and measure boundaries and quantization. Four resolutions and triplets are supported.

We have added a Track Copy/Merge Editor. This allows you to merge two tracks, replace a track (punch in/out), and copy a track.

Fractional BPMs are now displayed in the main menu. In addition, you can now change the BPM and the sequence will change its playback speed accordingly.

The current measure is displayed in the lower left-hand corner of the CRT during recording and playback. This helps in recording and editing.

This revision handles an external clock timer source more transparently. You input clocks per beat and time signature with measure commands stored while recording.

There is a provision for automatically loading program groups into the instruments when a sequence is loaded.

The catalog display has been improved. All music data file types are more descriptive.

Significant internal changes have been made to allow easier upgrades to future Fender instruments.

REV 5 SEQUENCER:

This revision provided an expanded note capacity of 8000 notes with the addition of RAM hardware. Nonexpanded note capacity dropped to approximately 1700 notes.

An externally syncable arpeggiator was included.

Parameter display of the current Chroma program was provided by a User Utility overlay.

Multiple instruments were made available from the Chroma keyboard.

The disk catalog was made easier to use. Basically, the catalog was changed to display only those files that the user was interested at the time of catalog invokation. The catalog would continue to be displayed while the user inputted the file name.

Many questions asked of the user during RECORD mode were removed and replaced with defaults. The Sequencer was changed to ask the user the name of the sequence only during save operations. The track name was automatically set to 'Tn', instead of asking the user to type in the name. The user could change the name as always using ^N - RENAME TRACK.

An abort capability when entering RECORD mode was provided.

There were a number of bugs found in this revision:

    The Arpeggiator would crash intermittently if an instrument was connected to the Expander port.

    The Parameter Display utility suffered a fatal SYNC error during rapid program changes.

    A round-off bug in determining speed from user inputted BPM was present.

    Certain combinations of sequence file sizes under expanded RAM failed to save to disk properly.

    Multiple program records did not work except on track 1.

Inserting MEASURE commands via the Editor clobbered
certain measure pointers. This caused Play mode to
terminate prematurely and disallowed the user to set the
endpoints.

REV 4 SEQUENCER:

This revison had a nonexpandable note capacity of around 1800
notes.

It handled pressure information and allowed recording pressure
from the Chroma port.

It was compatible with the Apple IIe as well as the II Plus.

External syncing was simplified by an automatically invoked User
Utility that inserted a TIME 0 command at the end of recording
the first track of an externally synced sequence.

There were many additional features in the H menu selection (see
Chapter 11), including programmable transposition presets.

There were a number of bugs found in this revision:

When the first track of a sequence was zapped, further
recording would produce a 'second' sequence. The first
sequence was sometimes empty. The user experienced this
as unpredictable play operations. Sometimes a SYNC error
or DEF error would occur, sometimes the sequence would
alternate between playing properly and coming back to the
main menu without playing the sequence. It was, in fact,
playing an empty sequence.

When an external clock was used during recording and a
memory full condition was reached, the Sequencer stored a
TIME 0 command where there was no memory space. The
result was lost sequence data.

Loop mode recording did not allow the use of a computer
key to initiate the 'cued' mode. The result was that if
the user pressed a key in 'looping' mode, the recording
was terminated. If the footswitch was turned OFF in
RECONFIGURE, there was no way to record in loop mode.

In the Interface Test program, the 'EXPANDER NOT
RESPONDING' message read '2 DOWN' which doesn't make
sense.

Various I/O routine bugs were found involving queue handling. These errors surfaced while experimenting with instruments much slower than the Chroma.

The Editor set the endpoints to the beginning and ending, without restoring them upon exit to the main menu.

When inserting MEASURE commands in the Editor, the internal measure registers where not updated to reflect the changes. The result was that the user could not always reference a MEASURE inserted by the Editor as an ENDPOINT.

The Editor did not trap certain illegal operations on END OF SEQUENCE and BEG OF SEQUENCE commands. It was possible to destroy sequence pointers, thereby losing sequence data.

REV 3 SEQUENCER:

This was the initial field release version of the Sequencer. The version worked only on an Apple II Plus and did not support pressure information.

A couple of bugs were found in this revision:

The LOAD SETUP operation in RECONFIGURE set the disk slot to 7. If the disk controller was actually in a different slot, the system would hang on disk accesses after loading a setup.

The EDIT TRACK LIST in the Editor was cleared upon entry to the Editor, requiring the user to reenter the track list.

Upgrading The Sequencer Software:

When the customer purchases the Chroma Computer Interface Kit, he is required to register his purchase by returning the enclosed Warranty Registration Card. We use this card to obtain the addresses when we mail revision update notices. _It is important that you return the Warranty Registration Card or you will not be notified of updates._

The cost of the update or upgrade will be included in the revision notice. We try to hold revision costs to a minimum. If you purchase old software within specified time periods of an update, you may get a discount on the update. The time schedule is also included in the update notice.

An update usually consists of a Drive 1 diskette and any changes in the manual text. Since the manual is contained in a loose leaf notebook it is rare that the whole manual be replaced. It is even more unusual to include a Drive 2 diskette in an update.

THE INTERFACE TEST PROGRAM

The USER UTILITY 20 program overlay is a small test program designed to allow the user to determine that his hardware is functioning properly.

To access the program, type ^V for the USER UTILITY bank 2, then type 0 and <RET> for user number 0. The program will then be loaded and an initialization procedure will be ran. The display will indicate the status of the two ports. If the Sequencer tells you that either port is not responding then you either have a problem with that port or no instrument is connected.

In the case of a port error, the error code number is displayed on the left of the message line. The following values are possible:

1 - The Chroma port is not responding to 260 NOPs.
    This means that the port is not responding to
    output. The cable is disconnected or improperly
    functioning. The handshaking flip-flop (Z11)
    should also be suspected, as well as Z12F or
    Z14B.

2 - The Expander port is not responding to 260 NOPs.
    This means that the port is not responding to
    output. The cable is disconnected or improperly
    functioning. The handshaking flip-flop (Z1) or
    Z14A should also be suspected.

3 - The Chroma port is not responding to input
    requests. The cable is disconnected or
    improperly functioning. Also, suspect Z12D,
    Z14B, or the input interrupt logic circuitry.

4 - The Expander port is not responding to input
    requests. The cable is disconnected or
    improperly functioning. Also, suspect Z14B.

5 - The Chroma port is not responding to output, the
    queue is full. Essentially the same as 1 above.

6 - The Expander port is not responding to output.
    Essentially the same as 2 above.

7 - The Chroma port is not echoing the ID command.
    The instrument on the port is confused. This is
    usually caused by a bad cable or the data lines
    shorted, open, or crossed.

8 - The Expander port is not echoing the ID command.
    The instrument on the port is confused. This is
    usually caused by a bad cable or the data lines
    shorted, open, or crossed.

Refer all servicing to an authorized Fender Service Center
or the Fender Service Department. This program is not intended
to replace the Service Center function.

The Interface Tester is a command oriented program. Below
is a short description of each command and the subcommands
allowed within each operation:

^I - REINITIALIZE

This command will attempt to send 260 NOPS to the
Chroma and Expander port. Will initialize the output
buffer for the OUTPUT commands described below. Will
display the status of the two ports.

^T - TIMER TEST

This command will initialize the timer registers to
zero and display the counts as they occurr. The timer
source (internal, external, or single step) and timer
increment will reflect the current set-up. Typing a
<SPACE> will pause the display. Typing an R will
reset the timer registers to zero. Typing a <RET>
will terminate the test. When using an internal or
high frequency external (1 KHz or higher) timer
source, a number that is missing in the sequence of
values may or may not indicate a missing timer pulse.

^A - ADC TEST

This command will read the ADC and display the values.
This is useful for setting the range trimpots on the
PC board. Typing a <SPACE> will pause the display.
Typing a <RET> will terminate the test.

^K - CLICK TEST

This command will output a click of 4/4 time at
approximately 120 BPM. Typing a <SPACE> will pause
the output sequence. Typing a <RET> will terminate
the test. This test takes TIMSRC and TIMINC into
consideration in determining the final output
frequency of the click.

^F - FOOTSW TEST

This command will display the current state of the
footswitch and any change in that state. Will reflect
the FOOTCK register in the current Reconfigure set-up.
Typing <RET> will terminate the test. The footswitch
input is not debounced on release, so you may see UP
DOWN UP when you release the footswitch during this
test.

^S - SYNC CHECK

This command will display the current state of the
SYNC input and any change in that state. This will
not reflect the current Reconfigure set-up. In other
words, this test will always check the SYNC input and
will only wait for one state change. Typing <RET>
will terminate the test. Since the SYNC input is not
debounced, mutiple states may be displayed when a
footswitch is used.

^C - CHROMA TEST

This command will output bytes to the Chroma port and
display the data received from the Chroma in response
to the output bytes. The sub-commands allowed are:

> ^D Delete last entry
> ^A Abort output
> ^M (<RET>) output the buffer
> any hex number (2 ascii chars) will
>   be put in the output buffer
>   (256 bytes maximum)

Good tests for the Chroma port are outputting the
following commands (and inspecting the response):

```
    OUTPUT -      ID : 01
    INPUT  -         : 01 01 (Chroma) 02 (REV 2)

    OUTPUT - WRPRG0 : 03 00 11 09 18 0F D7 F0
                      0A 00 F8 13 01 00 B0 7B
                      0C 00 FC FE 01 90 3D 80
                      C2 B5 89 97 36 00 00 01
                      C3 08 04 0F CB F0 00 00
                      18 0B 01 00 F8 7B 0C 00
                      7D 7E 01 90 3D 80 C2 AB
                      87 97 36 00 00

    INPUT  -        : No response from Chroma,
                      program waits forever until
                      user types a <RET>.
```

```
OUTPUT - RDPRG0 : 02 00 (Read Prog 0)
INPUT  -        : 02 11 09 18 0F D7 F0 0A
                  00 F8 13 01 00 B0 7B 0C
                  00 FC FE 01 90 3D 80 C2
                  B5 89 97 36 00 00 01 C3
                  08 04 0F CB F0 00 00 18
                  0B 01 00 F8 7B 0C 00 7D
                  7E 01 90 3D 80 C2 AB 87
                  97 36 00 00
```

Program waits forever until
user types a <RET>.

NOTE: A Chroma Polaris will return the last 15 bytes
as 00, regardless of what was sent.

^X – EXPANDER TEST

This command is the same as above, but will test the
Expander port.

^E – EXIT TEST

This command will exit the Interface Test Program and
return to the main menu.

<u>COPYING DISKETTES</u>

It is occassionally necessary to copy diskettes for backups, etc. It is principally for this reason that we have not copy protected the disks in the Sequencer system. We, in fact, encourage you to immediately make a back-up of the diskettes and use the back-ups. Store the originals in a safe, cool and dry place.

<u>Making New Sequence Data Diskettes</u>:

The sequence data diskettes for 2 drive systems are very easy to make. Creating a new data diskette for a single drive system is relatively more involved. The procedures required are outlined below:

Dual Drive System:

(1) Exit into Applesoft by typing <ESC> from the main menu.

(2) Type LOAD HELLO,D2 then <RET>.

(3) Take the original diskette out of drive two and replace it with the new unformatted diskette.

(4) Type INIT HELLO,D2 then <RET>.

(5) LABEL the new diskette.

Single Drive System:

(1) Exit into Applesoft by typing <ESC> from the main menu.

(2) Type LOAD HELLO then <RET>.

(3) Take the original diskette out of our drive and replace it with the new unformatted diskette.

(4) Type INIT HELLO then <RET>.

(5) Take the new diskette out of the drive and label it.

(6) Insert a 3.3 Master Diskette in the drive and type BRUN FID then <RET>.

(7)   Select FID menu item 1 (copy files) and specify the
      source and destination slot and drive to your disk
      controller slot and drive 1. Set filename to =
      (all files). Set prompt to no prompting. Follow
      instructions from here, inserting source disk (old
      disk) then destination disk (new disk) until the
      whole disk is copied. You will need to tell the
      computer to write over the HELLO program that
      already exists on the new diskette. We suggest
      you read the Apple DOS Manual before you use FID.

(8)   Put the new diskette in your drive and boot the system
      by typing PR#6 (or whatever your slot number is)
      then <RET>.

(9)   When you are in the main menu, type D for delete
      sequence and delete the sequences you do not want
      on this new diskette.

(10) Type Q for Program File Management, then select 3 to
      delete any program groups you do not want on this
      new diskette.

USING OTHER SYSTEMS WHILE THIS CARD IS IN PLACE

The current hardware in the Interface PC board may cause compatibility problems with other cards that use or inadvertently enable the interrupts. The Interface PC card never stops generating interrupt requests if the card is running on the internal clock. Whether the card operates from the external or the internal clock is random upon power-up. If the Interface card is installed and another system is booted that uses or enables the interrupts, our card can impede proper operation of that system. We recommend that you either remove the Interface PC card when not running our system or perform the following instructions before booting the other system:

(1) Turn on the Apple with the Master Diskette or other diskette that does not enable the interrupts.

(2) Remove any External Clock input from the Interface Connector Chassis.

(3) From Applesoft, type PRINT PEEK (number1) <RET> then POKE number2,0 <RET> then POKE number3,0 <RET>. The value of number1, number2, and number3 depend on the interface card slot. See the table below for your numbers:

SLOT	number1	number2	number3
1	-16240	-16237	-16235
2	-16224	-16221	-16219
3	-16208	-16205	-16203
4	-16192	-16189	-16187
5	-16176	-16173	-16171
6	-16160	-16157	-16155
7	-16144	-16141	-16139

(4) THEN boot the desired software package (without turning off the computer).

This enables the EXTERNAL CLOCK and clears the interrupt request line. If no clock signal is inputted then interrupts will not ocurr from the Interface PC card.

The user could modify the HELLO program in the system he wants to run to do this before it enabled the interrupts. The Apple powers up with interrupts disabled.

It is also possible to insert a SPST switch in series with the IRQ line on the Interface PC board (the collector of Q1). The switch could be mounted in the extra jack cutout in the connector box assembly. Performing the modification will void your warranty unless performed by an authorized Fender Service Center.

HARDWARE DESCRIPTION AND SPECIFICATIONS

A Schematic and component layout drawing of the Interface PC board is included in this section for your reference. It is included solely for the purposes of explanation and is not to be used for servicing your own board. Refer servicing to an authorized Fender Service Center or call the Fender Service Department.

Also, please obey the law regarding copyrights!!!

The Interface PC Card:

The hardware of the Interface PC Board is divided into the following sections:

(1) I/O Address Decoder
(2) Chroma Port
(3) Expander Port
(4) Interrupt Control
(5) Click Output
(6) Clock Circuit
(7) Analog to Digital Converter
(8) Status Input Port

Interconnection is provided by:

- The Apple Slot edge connector, which allows communication with the Apple and supplies the power (approximately 160 milliamps from +5V, 60 milliamps from +12V and 40 milliamps from -12V). The slot connector pin numbers are represented by small rectangular blocks on the Schematic Diagram.

- The 8 pin phono jack connector (J7), which supplies the Click output and the Pedal, Footswitch, Sync and External Clock inputs.

- The two 26-pin port connectors J5, the Chroma port, and J6, the Expander port.

I/O Address Decoder:

The address decoder circuitry uses the DEVICE select, R/W,
Phase 1 clock and three least significant address lines to decode
the addresses of the various I/O functions of the Interface Card.
The software locations of these functions are detailed in
APPENDIX J and will not be repeated here. The outputs of Z10 and
Z15 are active low enable pulses that are used to latch data
and/or enable the reading of data from tri-state buffers. They
are also used to provide control pulses for clearing the
interrupt, starting the ADC, selecting the timer source and
outputting a click track pulse.

Chroma Port:

The Chroma port consists of an 8-bit input port with
handshaking and an 8-bit output port with handshaking. The port
connects to a mirror image of itself in the Chroma; that is, each
input port line (mnemonics starting with XI) connect to the
corresponding output port line (mnemonics starting with XO) at
the other end of the interface. The interface really only
consists of the output latch (Z5), the input tri-state driver
(Z7), the four NAND gates and an inverter. The two transistors
Q3 and Q4 are for isolation when the power is shut off. All he
other stuff is just for noise rejection. When the Sequencer
wants to transmit a byte of data, it checks the XOFULL line by
reading the Status Input Port to see if the last byte it sent has
been received yet. When it has, it writes the byte into the
latch with the WREXTO strobe coming from the I/O Address Decoder.
This causes the flip-flop consisting of gates Z11a and Z11b to be
set, and pulls the XOFULL line low. This tells the Sequencer
that the output port is full (and not to send any more data yet)
and tells the other end of the interface that there is fresh data
to be had. When the other end reads the data, it will pulse the
acknowlege line XOACK, which resets the flip-flop and resets
XOFULL high (inactive) again. This tells the Sequencer that it
can send another byte of data.
The input interface performs the other side of the same
task. When data arrives from the other end via the XI lines, the
XIFULL line will go low, telling the Sequencer that the fresh
data has arrived. When it reads it, using the RDEXTI strobe,
the acknowlege XIACK will be pulsed, causing the flip-flop at
the other end to be cleared, and causing XIFULL to go high
(inactive) again.
The remaining gates Z11d and Z11c are used to allow masking
of the XOFULL and XIFULL lines for interrupt control.

Interrupt Control:

Normally, the Sequencer is ready to accept data from the
interface, and the XIMASK line from Z16b is high (inactive).
This means that an incoming byte, which is accompanied by XIFULL
going low, will cause the input of Z12c to go low, turning on Q1
and interrupting the Apple. The only times the Sequencer
activates XIMASK to prevent input interrupts is if the device at
the other end of the interface is sending data faster than the
Sequencer can process it.

Normally, the Sequencer has no data to transmit, and if it
does, the interface is usually ready for it, as signified by a
high (incative) XOFULL. If, however, the Sequencer has data to
send and the output port is still full from the previous data
transfer, the Sequencer will store the byte of data in a FIFO
(first in first out) queue in its memory and set XOMASK high
(inactive) from Z16a, thus unmasking output port interrupts. The
output port interrupt occurs whenever the device at the other end
of the interface gets around to reading the data off the
interface and sending back an XOACK pulse. Then the Sequencer
will take time out from whatever it is doing to pull a byte from
the end of the FIFO queue and output it. Only when the queue is
empty does the main computer mask output interrupts again by
setting XOMASK low (active).

Upon power-up, the XOMASK is set low (active) and XIMASK is
set high (inactive) by the system RESET line.

Interrupts can also occur from the Clock Circuit.
Interrupts from the Clock Circuit cannot be masked, see APPENDIX
N.

The Sequencer determines the source of the interrupt by
reading the XOFULL, XIFULL and TIME lines from the Status Input
Port.

Expander Port:

The Expander Port works exactly like the Chroma Port except
it is polled instead of interrupt driven. The Sequencer
determines the state of the port by reading the XXFULL and IXFULL
lines from the Status Input Port.

Status Input Port:

The Status Input Port consists of two tri-state drivers that
buffer the state lines of the interrupt sources as described
above. It also allows the Sequencer to read the state of the
FOOTSWITCH, SYNC and Analog to Digital Converter. The RC network
of R19/20 and C42 provide some debouncing of the FOOTSWITCH.

Click Output:

The Click Output consists of Z17b, R36 pullup and bandpass filter R16/C35/R17. A 100pF capacitor at the Click Out Jack completes the filtering. Everytime the click address is accessed via the I/O Address Decoder, the output of Z17b toggles, generating a pulse at the Click Out Jack. Emphasis is placed on the first beat of the measure by outputting two pulses, 42 microseconds apart, for subsequent beats of the measure. Two pulses this close together reduce the low frequency energy and the pulse sounds lower in volume.

Clock Circuit:

The Clock for the Sequencer can be either an internal clock of 1000 Hz or an external clock of any frequency between DC and 3000 Hz. The lower the frequency, the less recording/playing resolution available. Ideal input frequency is 1000 Hz whereas 24 Hz is barely acceptable and frequencies above 3000 Hz will keep the Sequencer in constant interrupt service. For more information about the external clock frequency, see Chapter 10.

The flip/flop consisting of Z1c and Z1d allows switching between internal and external clocks by addressing the location decoded by the I/O Address Decoder.

The internal clock of 1000 Hz is generated by dividing the 1M Hz system clock by 1024 in Z19. The internal clock is disabled by pulling the reset line high, forcing the Q10 output to remain low.

The external clock circuitry consists of Z18b comparator circuit and associated components. This circuit senses when the input voltage crosses zero plus a .05V hysteresis level, at which time the output of Z18b saturates at the negative supply level. When the input falls below -.05V then Z18b switches back to the positive supply level. The circuit is enabled by a low level at the output of Z1c and creates an input voltage divider R47 and R42. When Z1c is high, the input of Z18b will always be high enough to keep it from switching and the output will be negative.

The output of Z18b is rectified, divided and filtered so that it is compatible with the clock input of Z17a (0V to 5V), which generates the interrupt. R48 is necessary to offset the effect of the nonsymmetrical load of Z18b. The interrupt is cleared by a pulse from the I/O Address Decoder when the Sequencer has determined, by reading the Status Input Port, that the interrupt came from the timer.

Analog To Digital Converter:

The ADC circuit is centered around the National 0804 single channel IC. The circuit converts the resistance of a 100K linear potentiometer in the pedal housing to a digital value between 0 and 255.

The reference of the ADC is set by R25. This effectively adjusts the range of digital values obtained. The minus input for the ADC is set by R29. Adjustment of this trimmer sets the zero value with the pedal all the way up. The Z18a circuit converts the pedal resistance to a voltage source with low impedance, which is sent to the ADC for conversion.

Conversion ocurrs within 100 microseconds and the INTR line goes low, telling the Sequencer that a conversion is finished. When the Sequencer reads the ADC value, the RD line goes low and the digital data is sent to the Apple via the Z8 buffer. The ADC conversion process is started again by pulling the WR line low on the 0804, which is done by the pulse from the I/O Address Decoder after the Sequencer reads the value.

It is possible to open circuit R33 and feed a 0-5V control voltage in the pedal input if you desire. Performing the modification will void your warranty unless performed by an authorized Rhodes Chroma Service Center.

ADC Adjustment Procedure:

To adjust the ADC zero point and range, it is necessary to continuously view the value of the control pedal. You can do this by running USER UTILITY BANK 2, NUMBER 1 (ADC TEST) or USER UTILITY BANK 2, NUMBER 0 (the preferred Interface Test Program). Number 1 displays the value in decimal from 0 to 255 and NUMBER 0 will display the pedal value in HEX from 00 to FF when the ^A command is issued (see APPENDIX L).

Once the Sequencer is continuously displaying, push the pedal all the way in the up position and adjust trimpot R29 (the one closest to the rear of the APPLE) for 00 display. You should first adjust R29 until you start seeing 01's then back off until it is always 00. Then push the pedal all the way down and adjust trimpot R25 (the one closest to you) for FF (or 255 decimal) display. You should adjust from FE until the display always reads FF. Then push the pedal all the way up again and readjust for 00. Exit the ADC Test mode by typing a <RET> and exit the Interface Test Program by typing ^E.

Sync, External Clock, and Click Signal Specifications:

SYNC Input:

LEVEL : 0V to 5V, TTL (external device must be able to sink .9
              mA @ .8V max, can use open collector because input
              is pulled up by 10K).

SPEED :Ton (min) = Toff (min) = 52 microseconds in SYNC CHECK
              mode (1.5 milliseconds in Single Step2 mode).

NOTE : If a footswitch is used for this input, it should be
debounced unless sync delay is set to zero. Both single step
timer sources debounce this input in software.

EXT CLK Input:

LEVEL : .7Vp-p minimum, 22Vp-p maximum.

INPUT IMPEDANCE : approximately 100K ohms.

WAVEFORM : Sine or Square (duty cycle 25% to 75%).

MINIMUM FREQUENCY : 0 Hz (although for useable resolution, a
                     minimum of 100 Hz is recommended).

MAXIMUM FREQUENCY : depends on complexity of sequence but
                     generally should be limited to 3000 Hz.

INTERNAL TIME INCREMENT : Adjustable from 1/16X to 8X clock
                          frequency in powers of 2. This is
                          used to match external clock as close
                          as possible to internal clock if you
                          want to switch clocks after you
                          record the sequence.

CLICK Output:

OUTPUT LEVEL : -2V TO +2V nominal.

OUTPUT IMPEDANCE : 10K ohms.

SPECIAL NOTES ON CHROMA POLARIS SUPPORT

In this Sequencer revision, the Chroma Polaris is fully
supported as a musical input/output device. It can be used on
either the Chroma or the Expander port, for recording or
playback. This Appendix discusses topics specific to the
Polaris- its behavior under certain circumstances and interface
features that are not present in the Chroma or Chroma Expander.
Wherever applicable, it will direct you to manual sections that
discuss the Polaris in detail.

Notes:

i) Support for Polaris sequences is two fold. The sequences
can be directly saved and loaded from disk via the Y-POLARIS SEQ
menu selction (see Chapter 7). Polaris sequences can also be
transferred to and from the Sequencer via recording and playing.
This allows each of the two devices to take advantage of the
other's features (see Chapter 5).

ii) Whenever a Polaris is connected to a port referenced
throughout the Sequencer program, the program number is displayed
in the Polaris notation (i.e. B6). Whenever the program number
is inputted only the Polaris notation is accepted for a port that
has a Polaris connected to it (see Chapter 6).

iii) Whenever possible, the Sequencer references an
instrument on a port by name (i.e. "POLARIS ON LINE"). This
reminds the user of the current music system setup.

iv) The dynamic channel allocation feature of the Polaris
makes the instrument extremely applicable to multi-track
sequencing and Multi-Instrument applications. See Appendix H for
a discussion of channel allocation principles in the Chroma and
Chroma Polaris.

v) In Multi-instruments, the Sequencer may undefine i0,
which totally blanks the Polaris control panel (similar to
turning off the local control switch for the Main instrument).

vi) For Polarises of software revision less than eight (8),
the user should not use programs with the Pedal Initial parameter
set to a value other than zero (0) unless he moves the Polaris
pedal before playing notes during recording. As an alternative,
the user could insert (via the Editor) a PEDAL1 command with a
value of 255 in the sequence just after the DEFINE command for
that track.

vii) Multitracking in the Polaris involves defining instruments i2-i7, which requires additional RAM memory in the Polaris. This will create a memory full condition, causing the Polaris to honk and light its Memory Full LED. If you are going to be doing multitracking work with the Polaris, you should have fewer sequences and/or programs in the Polaris RAM.

viii) The Polaris has additional Chroma Interface commands and its responses to certain established commands are different than the Chroma. See Appendix I for a detailed description of these differences.

EXPANDER PORT

CHROMA PORT

I/O ADDRESS DECODER

CLICK OUTPUT

INTERRUPT CONTROL

ANALOG TO DIGITAL CONVERTER

CLOCK CIRCUIT

STATUS INPUT PORT

POWER

LTR	DESCRIPTION	DATE	APPROVED
9	RSC 432		
10	RSC 433		
11	RSC 434		
12	RSC 461		

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTOR VALUES ARE IN OHMS;
   1/4 W, 5%
   ALL CAPACITOR VALUES ARE IN μf.
   (P = PICOFARADS)
2. HIGHEST REFERENCE DESIGNATIONS:
   Z19, C56, R50, CR4, Q7, J7, E10
3. J5-5&7, J6-5&7 NOT USED.
4. CONVENTIONS USED FOR SUPPLY
   VOLTAGE CONNECTIONS:

↑ IMPLIES +12V ANALOG
↓ IMPLIES -12V ANALOG
△ IMPLIES ANALOG GROUND
▽ IMPLIES +5V DIGITAL
▽ IMPLIES DIGITAL GROUND
⊥ IMPLIES CHASSIS GROUND

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SCHEMATIC, PC BD, CHROMA/COMPUTER INTERFACE

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SCALE NONE SHEET 1 OF 1

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